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Study Summary

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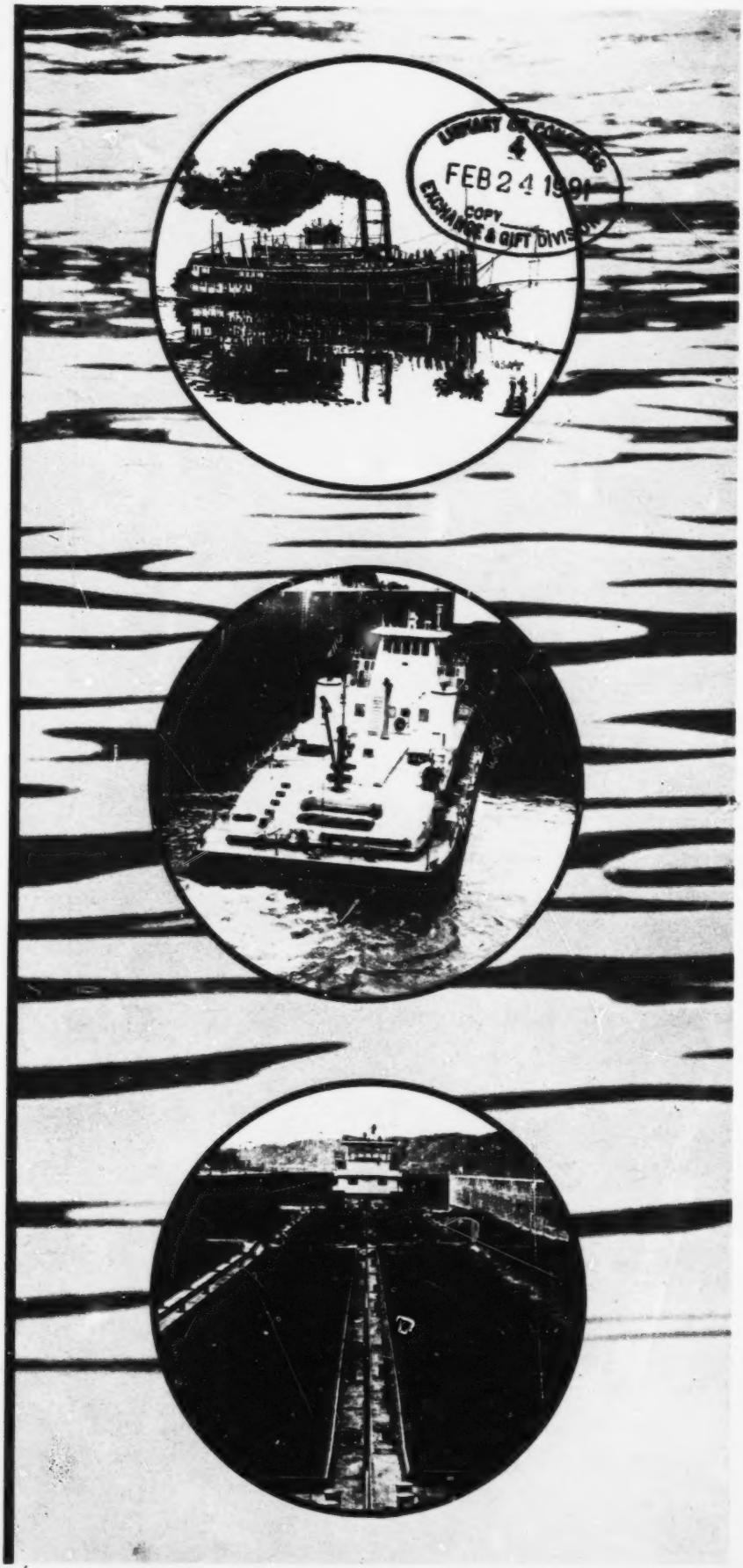
317

Projections Of Demand For Waterborne Transportation

Ohio River Basin
1980 - 2040



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System. Each of the studies considers existing waterborne commerce and develops a consistent set of projects of future traffic demands for all of the navigable waterways of the Basin. Each report contains information on past and present waterborne commerce in the Basin and projections by commodity groups and origin-destination areas from 1976 to at least 1990.

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(Continued from #20)
The three study projections, in conjunction with other analytical tools and system information, will be used to evaluate specific waterway improvements to meet short and long-term navigation needs. The output from these studies will serve as input to Corps' Inland Navigation Simulation Models to help analyze the performance and opportunities for improvement of the Ohio River Basin Navigation System. These data will be used in current studies relating to improvement of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, the Cumberland River and the Tennessee River, as well as other improvements.

This document is volume 1, Study Summary, of the final 17 volume report.

The study included a Commodity Resource Inventory, a Modal Split Analysis and a Market Demand Analysis. The work included investigation and analyses of the production, transportation and demand characteristics of each of the major commodities transported on the Ohio River and its tributaries. For each of 15 commodity groups, the demand for waterway transportation into, out of and within the Ohio River Basin was projected through the year 2040. A detailed study analysis and discussion for each commodity group is presented in 15 individually bound reports, supplemented by a methodology report. A study summary aggregates the commodity group totals for each of the several projections periods and lists the total waterborne commerce for each of the 72 operational locks and dams in the Ohio River Basin. The study results are presented in the following 17 documents:

Volume	Subject Title	
1	Study summary	
2	Methodology	
3	Group I:	Coal and coke
4	Group II:	Petroleum fuels
5	Group III:	Crude Petrol.
6	Group IV:	Aggregates
7	Group V:	Grains
8	Group VI:	Chemicals and chemical fertilizers
9	Group VII:	Ores and Minerals
10	Group VIII:	Iron ore, steel and iron
11	Group IX:	Feed and food products, nec.
12	Group X:	Wood and paper products
13	Group XI:	Petroleum products, nec.
14	Group XII:	Rubber, plastics, nonmetallic, mineral, products, nec.
15	Group XIII:	Nonferrous, metals and alloys, nec.
16	Group XIV:	Manufactured products, nec.
17	Group XV:	Other, nec.

Additionally, an Executive Summary is available as a separate document.

Volume 1 of 17

STUDY SUMMARY

PROJECTIONS OF DEMAND FOR WATERBORNE TRANSPORTATION OHIO RIVER BASIN 1980, 1990, 2000, 2020, 2040

Prepared for

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION, HUNTINGTON DISTRICT

Contract No. DACW69-78-C-0136

by

Robert R. Nathan Associates, Inc.
Consulting Economists
Washington, D.C.

DECEMBER 1980

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CONTENTS: v.1. Study summary.--v.2. Methodology.--v.3. Commodity groups .

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PREFACE

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River basin navigation system. Each of the studies considers existing waterborne commerce and develops a consistent set of projections of future traffic demands for all of the navigable waterways of the basin. Each report contains information on past and present waterborne commerce in the basin with projections by commodity group and origin-destination areas from 1976 to either 1990 or 2040.

The three projections, in conjunction with other analytical tools and waterway system information, will be used to evaluate specific waterway improvements required to meet short and long-term navigation needs. The output from these studies will serve as input to Corps inland navigation simulation models to help analyze the performance and requirements for improvements of the Ohio River basin navigation system. These data will be used in current studies relating to improvements of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, and the Tennessee River, as well as for other improvements.

The reports on the three studies are referred to as the "CONSAD," the "BATTELLE," and the "NATHAN" reports. The latter and final report was completed in November 1980. It was prepared for the Corps of Engineers by Robert R. Nathan Associates, Inc., Consulting Economists, Washington D.C. This study encompasses the period 1976-2040, and is by far the most detailed of the three.

The "CONSAD" report, completed in January 1979, was prepared for the Corps by the CONSAD Research Corporation of Pittsburgh, Pennsylvania. The study and the 1976-1990 projected traffic demands discussed in that report were developed by correlating the historic waterborne commodity flows on the Ohio River navigation system, with various indicators of regional and national demands for the commodities. The demand variables which appeared to best describe the historic traffic pattern for each of the commodity groups was selected for projection purposes. The projected values for the demand variables are based upon the 1972 OBERS Series E Projections of National and Regional Economic Activity. The OBERS projections serve as national standards and were developed by the Bureau of Economic Analysis of the U.S. Department of Commerce, in conjunction with the Economic Research Service of the Department of Agriculture.

The "BATTELLE" report was completed in June 1979, and was prepared for the Corps by the Battelle Columbus Laboratories, Columbus, Ohio. The study and the 1976-1990 traffic projections discussed in that report were developed by surveying all waterway users in the Ohio River Basin through a combined mail survey and personal interview approach. The purpose of the survey was to obtain an estimate from each individual shipper of his future commodity

movements, by specific origins and destinations, as well as other associated traffic information. All identifiable waterway users were contacted and requested to provide the survey information. In addition, personal interviews were held with the major shippers. The responses were then aggregated to yield projected traffic demands for the Ohio River navigation system.

The "NATHAN" report presents the findings of a commodity resource inventory, a modal split analysis and a market demand analysis. The work included investigation and analyses of the production, transportation, and demand characteristics of each of the major commodities transported on the Ohio River and its tributaries. For each of 15 commodity groups, the demand for waterway transportation into, out of, and within the Ohio River basin was projected through the year 2040. A detailed study analysis and discussion for each commodity group is presented in 15 individually bound reports, supplemented by a methodology report. A Study Summary and an Executive Summary present appropriately abbreviated discussion and findings resulting from these analyses. The Study Summary aggregates the commodity group totals for each of the several projection periods and lists the total waterborne commerce for each of the 72 operational locks and dams in the Ohio River Basin.

The "NATHAN" report, "Projections of Demand for Waterborne Transportation, Ohio River Basin, 1980, 1990, 2000, 2020, 2040" consists of the following volumes:

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Study Summary	220	1
Methodology	118	2
Group I: Coal and Coke	134	3
Group II: Petroleum Fuels	66	4
Group III: Crude Petroleum	42	5
Group IV: Aggregates	64	6
Group V: Grains	131	7
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Group VIII: Iron Ore, Steel and Iron	104	10
Group IX: Feed and Food Products, Nec.	44	11
Group X: Wood and Paper Products	61	12
Group XI: Petroleum Products, Nec.	38	13
Group XII: Rubber, Plastic, Nonmetallic Mineral Products, Nec.	41	14
Group XIII: Nonferrous Metals and Alloys, Nec.	57	15
Group XIV: Manufactured Products Nec.	35	16
Group XV: Others, Nec.	48	17

Additionally, an Executive Summary is available as a separate document.

RRNA

PROJECTIONS OF DEMAND FOR WATERBORNE TRANSPORTATION OHIO RIVER BASIN 1980, 1990, 2000, 2020, 2040

Study Summary

Prepared for
U.S. Army Corps of Engineers
Huntington District
Contract No. DACW69-78-C-0136

by
Robert R. Nathan Associates, Inc.
Consulting Economists
Washington, D.C.

November 1980

FOREWORD

The Ohio River Basin (ORB) includes parts of 14 states in the east central United States. The Basin has a drainage area of 204,000 square miles, extending from the Appalachian Mountains in the east, through the flat farmland of the eastern Corn Belt, to the banks of the Mississippi River. In addition to the diverse nature of its geography, the economy also is diverse. The Basin includes industrialized cities, such as Pittsburgh and Cincinnati, the mining centers of the Appalachian coal fields, and the fertile agricultural lands of southern Illinois, Indiana, and Ohio.

The Basin's industries play a major role in the Nation's economy. In 1976, approximately 64 percent of nationwide coal production, almost 30 percent of the Nation's steel production and 11 percent of U.S. corn and soybean output were produced in the areas served by the Ohio River and its tributaries.

A major factor that has contributed to the economic development of the Basin has been water transportation. The waterways have facilitated the movement of many rich resources and products to and from other areas of the Nation. The Ohio River System is comprised of the Ohio River and eight navigable tributaries: the Allegheny, Monongahela, Kanawha, Kentucky, Green, Cumberland, Tennessee, and Clinch Rivers. These rivers comprise a system of more than 2,600 miles, made navigable through a network of 72 lock and dam projects.

The Commodity Resource Inventory, Modal Split Analysis and Market Demand Analysis, Ohio River Basin, were undertaken by Robert R. Nathan Associates, Inc. (RRNA) for the U.S. Army Corps of Engineers, Huntington District. Most of the investigation was conducted between September 1978 and August 1979. This study was part of a series of efforts performed under the supervision of the Corps of Engineers to project the potential levels of waterborne traffic in the Ohio River System (ORS). The projections will be used by the Corps of Engineers as an input to the water resources development activity for which the Corps has responsibility. This responsibility includes the construction and maintenance of the locks and dams of the inland waterway systems.

RRNA has analyzed and projected commodity movements into, from, and within the Ohio River Basin. The work has included investigation and analysis of the production, transportation and demand characteristics of each of the major commodities transported via the Ohio River and its navigable tributaries. For each commodity, the demand for waterway transportation, by origin and destination, has been projected through the year 2040.

Fifteen commodity groups, including coal, petroleum, grains, chemicals, and iron and steel, were analyzed separately. County-level historical and future production and consumption estimates were determined for these commodities. Projections included consideration of regional and national economic and legislative outlooks. Regional and national trends were assumed that reflect anticipated changes in the economic value of energy resources. RRNA also has identified and interpreted the factors influencing historical changes and/or shifts in the choice of transportation mode.

Through use of an interactive simulation model designed by RRNA point-to-point waterway flows have been projected. These waterway flows were allocated to each of the 72 operational locks and dams in the Ohio River Basin through the use of a program developed by the Corps of Engineers.

The major findings of this study include:

- Total annual waterborne traffic in the Ohio River System will more than double between 1976 and 2040, from 200.8 million tons to 438.7 million tons per year.

- The largest absolute increase in waterborne traffic is for coal and coke, projected to increase from 116.5 million tons per year in 1976 to 253.7 million tons in 2040.

- As a group, ore and mineral commodities are projected to demonstrate the highest rate of future change; much of the increase is projected to result from increased inbound shipments of alumina.

- Movements of petroleum and petroleum products are projected to decline, as are the regional production and consumption of these products.

In addition to the Study Summary and an abbreviated Executive Summary, a report for each of 15 commodity groups has been published. These individual commodity group reports explain in more detail the research methods and findings summarized here. There is also a Methodology Report which presents the basic study assumptions, research techniques, and projection methodology used during the study, as well as a description and explanation of the Flow Model used by RRNA to develop projections for port-to-port flows.

* * * * * * * * * * * *

RRNA gratefully acknowledges the cooperation of the many shippers, waterway operators, associations, state and federal agencies, and other interested parties who provided much of the basic information used for this study. We also thank the Huntington Corps of Engineers for its cooperation and assistance.

James R. Leonard served as principal-in-charge and Alanna Dwyer served as project director of this study of the ORB. Major analysis was performed by Larry Pham, Judith Kroll, Richard Blankfeld and Michael Hydock. In addition, Richard Jeffe, Jill Moroney, Maung Aung, John Noer, and Fenwick Yu participated in this study. Also, RRNA staff was provided valuable expertise with respect to specific commodities by E. Dean Baldwin, of Ohio State University, and Kenneth Allen.

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I. INTRODUCTION

This report provides a summary of results of the Commodity Resource Inventory, Modal Split Analysis and Market Demand Analysis, Ohio River Basin, undertaken by Robert R. Nathan Associates, Inc. (RRNA) for the U.S. Army Corps of Engineers, Huntington District. Additional discussions of the investigations and analyses performed are contained in the individual commodity group reports and the methodology report.

The main objective of this study was to project for the Ohio River System (ORS) waterway commodity flows by origin and destination port equivalents (PEs) through the year 2040. This objective was attained through the investigation and analysis of the production, transportation, and demand characteristics of each of the major commodity groups transported in the ORS. Figure 1 presents the Ohio River System, which is comprised of the Ohio River and eight navigable tributaries.

The projections of demand for waterway transportation are used by the Corps of Engineers as an input to the water resources development activity for which the Corps has responsibility. This responsibility includes the construction and maintenance of the locks and dams of the inland waterway system. The projections of this study specifically pertain to the waterway development in the ORS.

The 15 commodity groups that were analyzed include:

Group	Commodity/Product
I	Coal and coke
II	Petroleum fuels
III	Crude petroleum
IV	Aggregates
V	Grains
VI	Chemicals and chemical fertilizers
VII	Ores and minerals
VIII	Iron ore, steel and iron

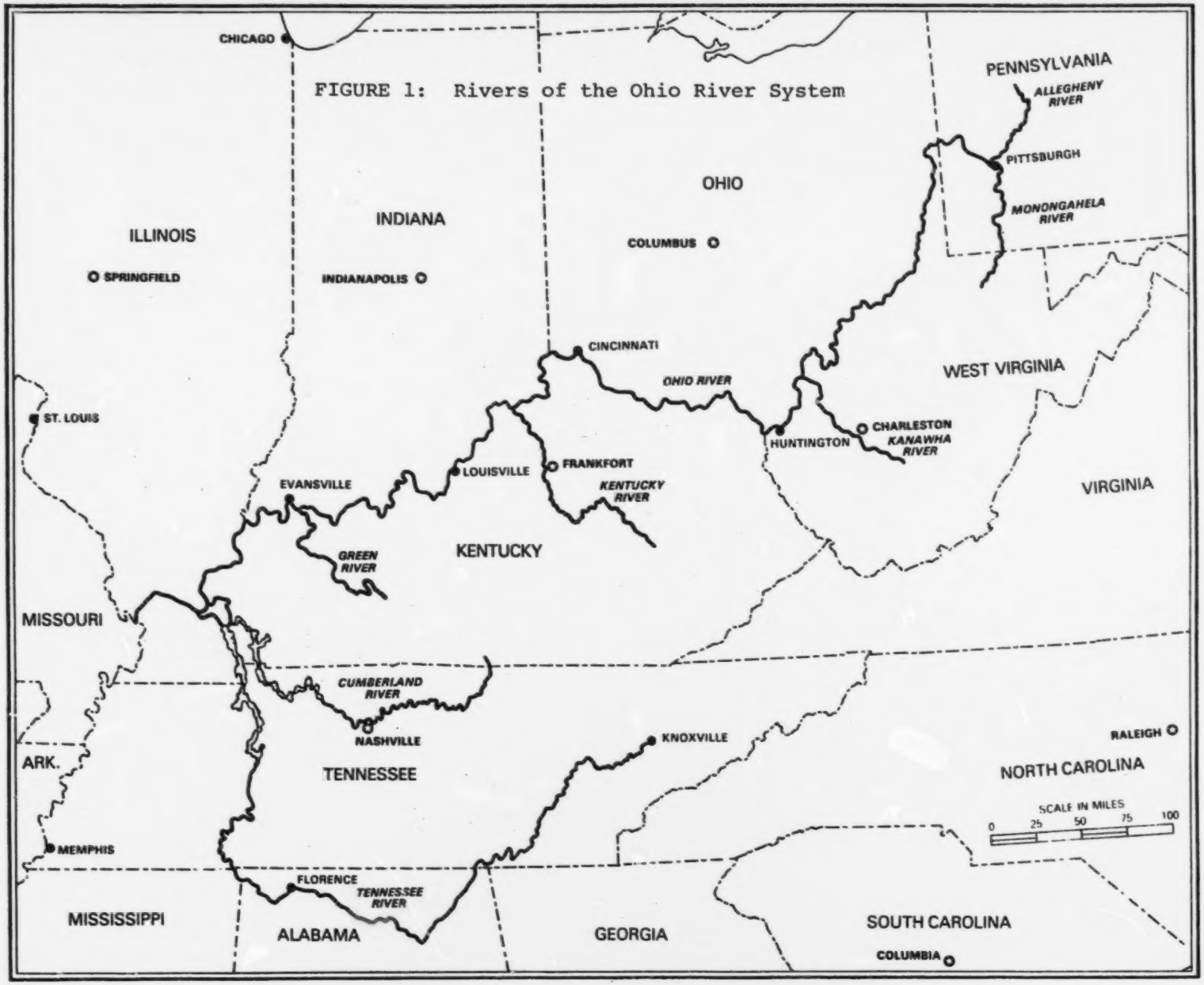

FIGURE 1: Rivers of the Ohio River System

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IX	Food and feed products, nec.
X	Wood and paper products
XI	Petroleum products, nec.
XII	Rubber, plastic nonmetallic mineral products, nec.
XIII	Nonferrous metals and alloys, nec.
XIV	Manufactured products, nec.
XV	Others, nec.

A listing of the individual commodities and products comprising each commodity group, by waterborne commerce statistics code, is provided in Appendix A to this report.

The ORS hinterland was defined as U.S. Department of Commerce Bureau of Economic Analysis Areas (BEAs) in the ORB that are the origins and/or destinations of waterborne movements. For some of the commodity groups, the ORS hinterland includes entire BEAs. For most commodity groups, however, the ORS hinterland is composed of BEA segments (only certain counties within a BEA). Figure 2 presents the BEAs of the Ohio River System that were the major focus of the investigation of commodity flows. The BEAs and the BEA segments that comprise the ORS hinterlands of the commodity groups have been designated as Primary Study Areas (PSAs). Production and consumption levels for each commodity group, by PSA, were projected, as well as their future movements, by transportation mode.

In addition to PSAs, external areas linked to the ORB through waterborne commerce were identified. Areas (BEAs) outside the ORB that are destinations of waterborne movements have been designated as the Secondary Consumption Areas (SCAs) for each commodity group. The areas (BEAs) outside the ORB that are origins of waterborne movements destined to the ORB have been designated as Secondary Production Areas (SPAs). Figure 3 presents the BEAs that have been identified as SCAs and/or SPAs of the ORB.

FIGURE 2. OHIO RIVER BASIN: PRINCIPAL BEA ECONOMIC AREAS OF THE REGION

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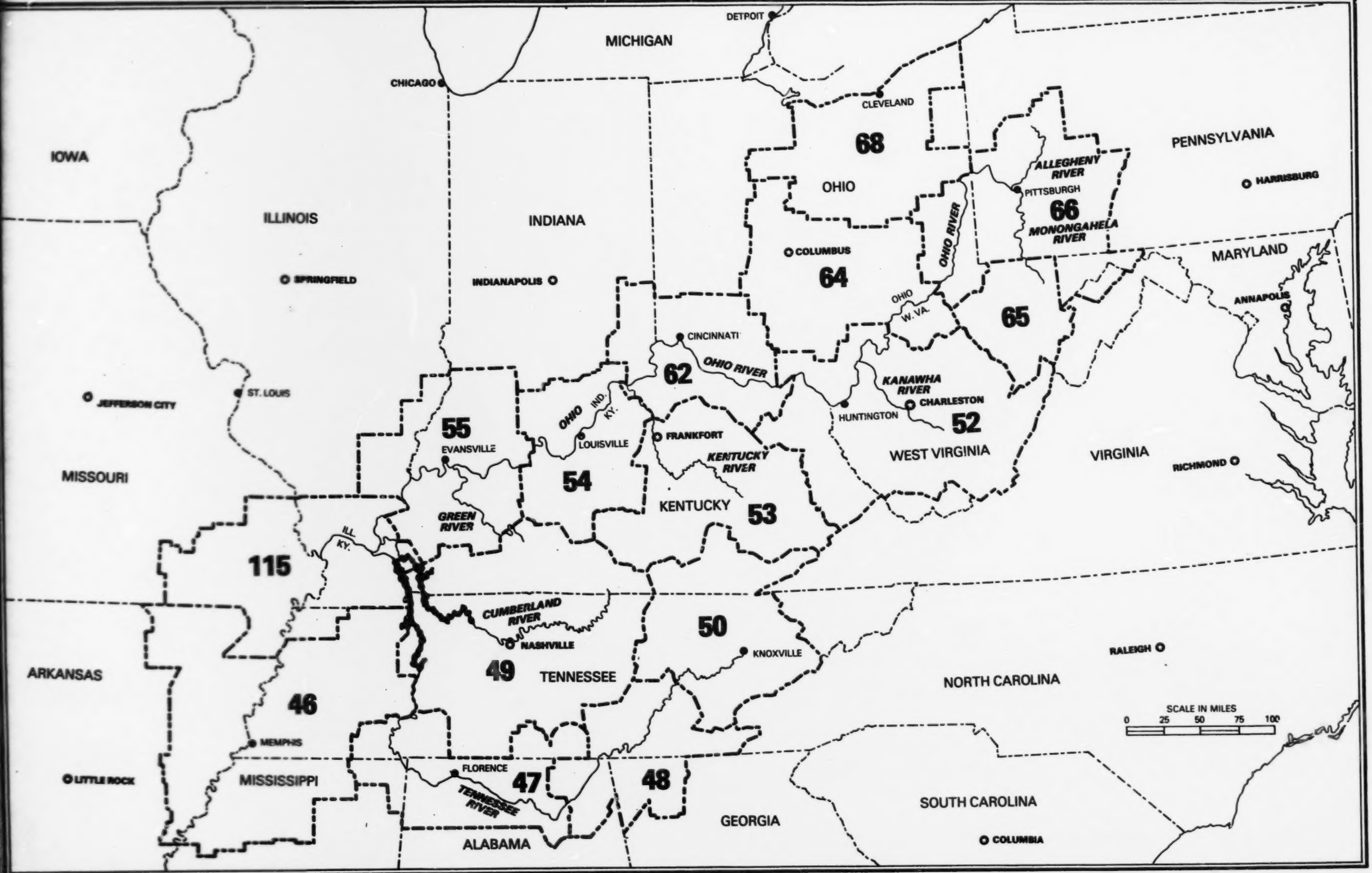

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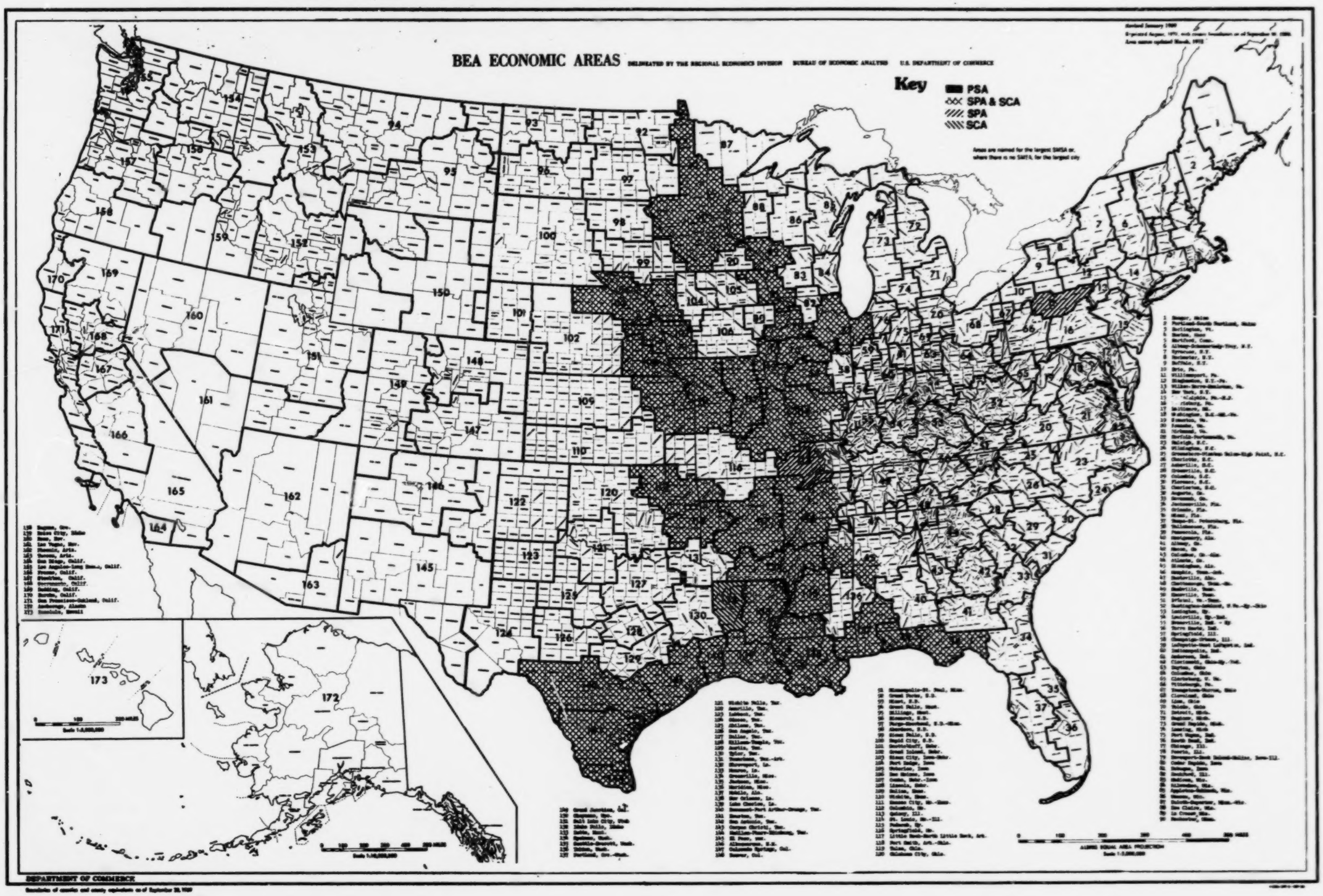
FIGURE 3. OHIO RIVER BASIN: SECONDARY PRODUCTION AREAS (SPAs) AND SECONDARY CONSUMPTION AREAS (SCAs) LINKED TO PRIMARY STUDY AREAS (PSAs) THROUGH WATERBORNE COMMERCE



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II. EXISTING WATERBORNE TRAFFIC

Waterborne traffic in the ORS totaled 67 million tons in 1950.[1] Ten years later, in 1960, commerce in the ORS had reached 105 million tons, an average annual increase of 4.6 percent.[2] By 1969, waterborne traffic was 161 million tons. During the years 1969-75, total ORS traffic remained in a range of 160 to 175 million tons (Table 1). In 1976, waterway traffic exceeded 200 million tons, an increase of 30 million tons over the preceding year. The substantial increase between 1975 and 1976 was the result of a 17 million ton increase in coal movements and a 7 million ton increase in aggregates traffic (which restored aggregates movements to earlier levels).

Coal and coke have been, and will continue to be, the major commodities (in terms of tonnage) moving by water in the ORS. Between 1969 and 1976, 55 percent of ORS traffic was coal and coke. In 2040, coal and coke are expected to contribute almost 58 percent of total ORS waterway traffic. This differs significantly from historical commodity movements within the Nation as a whole. In 1976, petroleum and related products accounted for 43.5 percent of U.S. waterborne commerce, whereas coal and coke contributed only 15.9 percent.[3] Most of the coal moving on the Nation's waterways has been shipped to, from or within the ORS. U.S. coal and coke waterborne movements totaled 156 million tons in 1976. Almost 75 percent of this traffic was linked to the ORS.

---

1. U.S. Army Corps of Engineers, Annual Report of the Chief of Engineers, 1951 ed. (Washington, D.C.: GPO, 1952), Vol. II.
2. U.S. Army Corps of Engineers, Waterborne Commerce of the United States, 1960 ed. (n.p.: COE, n.d.), Vol. II.
3. Excluding foreign commerce. U.S. Army Corps of Engineers, Waterborne Commerce of the United States, 1976 ed. (n.p.: COE, n.d.), Vol. V.

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Table 1. Ohio River System: Total Waterborne Commerce by Commodity Group, 1969-76

(Thousands of tons)

Group	1969	1970	1971	1972	1973	1974	1975	1976
Total: All groups	160,582.1	166,217.0	166,610.4	174,574.0	168,764.5	170,235.6	170,050.9	200,770.5
Group I: Coal and coke	86,957.5	89,700.1	84,716.0	94,177.1	91,566.8	92,561.3	99,655.8	116,532.9
Group II: Petroleum fuels	14,681.9	15,573.5	16,191.3	17,514.8	17,922.8	18,994.8	18,891.0	20,943.4
Group III: Crude petroleum	6,593.1	7,090.1	7,956.5	7,811.1	4,220.4	643.9	867.1	664.5
Group IV: Aggregates	23,003.6	21,583.1	24,073.1	22,618.1	23,679.4	23,110.5	18,972.3	25,152.3
Group V: Grains	3,304.1	3,375.6	3,973.3	3,119.6	3,012.6	3,355.0	4,097.3	5,582.0
Group VI: Chemicals, fertilizers	9,914.3	10,883.4	11,520.4	11,406.3	10,538.1	11,612.3	9,360.9	11,364.0
Group VII: Ores and minerals	3,558.0	3,966.9	4,462.2	3,744.4	3,160.5	3,819.3	3,523.8	4,451.0
Group VIII: Iron ore, steel	4,167.7	5,198.3	4,478.8	5,396.9	5,403.6	5,142.5	4,161.8	5,063.9
Group IX: Feed and food products	447.4	594.7	661.6	610.8	589.0	726.4	1,060.8	1,267.4
Group X: Wood and paper products	501.1	508.0	555.2	600.7	589.5	564.4	503.5	566.6
Group XI: Petroleum products	2,698.9	2,539.2	2,589.0	2,506.7	2,614.3	2,803.9	2,614.2	2,793.3
Group XII: Rubber, plastics	1,317.8	1,358.1	1,486.8	1,771.2	1,456.1	1,322.1	1,070.8	1,471.3
Group XIII: Nonferrous metals	41.6	43.1	117.9	103.2	72.5	88.9	181.7	246.9
Group XIV: Manufactured products	593.4	442.5	776.3	391.1	353.8	341.2	360.0	351.6
Group XV: Other, nec.	2,801.7	3,360.4	3,092.0	2,802.0	3,585.1	5,149.1	4,729.9	4,319.4

Source: Compiled by RRNA from Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

Most waterborne commerce in the Ohio River System is local (i.e., from one Port Equivalent (PE) to another in the ORS). In 1976, 72 percent of total waterborne ORS traffic was local (Tables 2 and 3). Local movements of coal and coke accounted for the bulk of these movements. Local waterborne shipments increased from 123 million tons in 1969 to 144 million tons in 1976 (Table 4).

During the period 1969-76, outbound waterway shipments from the ORS increased at an average annual rate of 7.1 percent, from 16.6 million tons to 26.9 million tons (Table 5). Most of this increase resulted from increases in the outbound shipments of coal and coke, grains (specifically, increases in corn shipments), and others, nec. (specifically, increases in waterway improvement materials).

Inbound shipments to the ORS increased at an average annual rate of 5.2 percent during the period 1969-76, from 20.7 million tons to 29.4 million tons (Table 6). Major increases were reported for coal and coke, petroleum fuels, and chemicals and chemical fertilizers.

Table 2. Ohio River System: Waterborne Commerce by Commodity Group, 1976

(Millions of tons)

Group		Total	Inbound	Outbound	Local
Total: All groups		200.8	29.4	26.9	144.5
Group I:	Coal and coke	116.5	2.6	12.6	101.3
Group II:	Petroleum fuels	20.9	8.8	1.3	10.8
Group III:	Crude petroleum	0.7	0.6	--	--
Group IV:	Aggregates	25.2	0.1	1.3	23.8
Group V:	Grains	5.6	1.4	4.0	0.1
Group VI:	Chemicals and chemical fertilizers	11.4	6.4	0.9	4.1
Group VII:	Ores and minerals	4.5	3.9	0.3	0.2
Group VIII:	Iron ore, steel and iron	5.1	2.0	1.5	1.5
Group IX:	Food and feed products, nec.	1.3	0.5	0.8	a
Group X:	Wood and paper products	0.6	a	a	0.5
Group XI:	Petroleum products, nec.	2.8	2.0	0.1	0.6
Group XII:	Rubber, plastic non-metallic mineral products, nec.	1.5	0.6	0.4	0.5
Group XIII:	Nonferrous metals and alloys, nec.	0.2	0.2	a	a
Group XIV:	Manufactured products, nec.	0.4	0.1	0.1	0.2
Group XV:	Others, nec.	4.3	0.1	3.5	0.7

Note: Individual items may not sum to total due to rounding.
a. Less than 0.05 million tons.
Source: U.S. Army Corps of Engineers, Waterborne Commerce by Port Equivalents, revised 1976.

Table 3. Ohio River System: Waterborne Commerce, Total, Inbound, Outbound, and Local, 1969 and 1976

(Millions of tons unless otherwise specified)

Type of movement	1969	1976
Total	160.6	200.8
Local	123.2	144.5
As a percentage of total	76.7	72.0
Inbound	20.7	29.4
As a percentage of total	12.9	14.6
Outbound	16.6	26.9
As a percentage of total	10.4	13.4

Source: U.S. Army Corps of Engineers, Waterborne Commerce by Port Equivalents, 1969 and revised 1976.

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Table 4. Ohio River System: Local Waterborne Commerce by Commodity Group, 1969-76

(Thousands of tons)

Group	1969	1970	1971	1972	1973	1974	1975	1976
Total: All groups	123,243.9	122,894.2	122,434.9	128,429.1	123,140.2	117,757.3	119,729.2	144,477.0
Group I: Coal and coke	77,077.5	78,372.6	74,038.2	81,168.6	79,091.9	78,453.8	85,259.4	101,348.0
Group II: Petroleum fuels	6,879.7	7,077.5	7,569.3	8,468.2	8,252.4	8,595.6	9,031.9	10,835.5
Group III: Crude petroleum	6,528.0	7,064.5	7,923.3	7,785.2	4,085.8	243.3	324.9	--
Group IV: Aggregates	22,509.6	20,342.2	22,772.8	21,440.3	22,762.0	21,256.4	17,649.8	23,816.8
Group V: Grains	152.2	129.5	125.0	114.8	170.5	115.4	120.1	129.0
Group VI: Chemical, fertilizer	4,651.2	4,941.2	4,924.4	4,141.9	3,591.0	3,865.1	2,899.1	4,115.6
Group VII: Ores and minerals	138.8	117.7	171.3	324.6	238.5	398.6	274.2	220.8
Group VIII: Iron ore, steel	2,044.9	1,906.1	1,929.0	2,143.6	2,175.4	1,768.4	1,290.1	1,518.0
Group IX: Feed and food products	44.9	65.9	63.9	38.1	27.8	14.7	39.3	37.8
Group X: Wood and paper products	322.9	317.1	396.5	453.7	468.6	458.3	404.5	515.3
Group XI: Petroleum products	790.1	574.5	656.1	545.8	464.6	486.8	573.6	636.0
Group XII: Rubber, plastics	649.9	720.5	798.8	997.1	706.5	521.0	391.0	461.1
Group XIII: Nonferrous metals	10.0	8.1	21.0	13.1	8.8	30.5	61.5	20.8
Group XIV: Manufactured products	250.5	181.3	328.2	206.4	200.6	201.0	167.1	164.8
Group XV: Other, nec.	1,193.7	1,075.5	717.1	587.7	895.8	1,348.3	1,242.7	657.5

Source: Compiled by RRNA from Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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Table 5. Ohio River System: Outbound Waterborne Commerce by Commodity Group, 1969-76

(Thousands of tons)

Group			1969	1970	1971	1972	1973	1974	1975	1976
Total:	All groups		16,629.5	20,140.5	19,479.5	21,431.9	20,236.9	24,106.3	23,541.4	26,854.0
Group	I:	Coal and coke	9,872.2	11,228.6	10,431.2	12,173.1	11,195.7	12,164.1	11,622.3	12,552.7
Group	II:	Petroleum fuels	1,080.7	1,084.5	1,010.6	1,076.3	934.6	1,142.5	1,107.7	1,293.1
Group	III:	Crude petroleum	42.7	--	--	--	--	7.5	70.2	--
Group	IV:	Aggregates	474.9	1,126.9	1,290.7	1,172.4	853.9	1,738.2	1,228.7	1,265.4
Group	V:	Grains	619.2	422.4	928.9	1,092.2	1,102.0	1,497.3	2,609.0	4,035.0
Group	VI:	Chemicals, fertilizers	954.0	919.8	1,011.9	1,119.6	895.6	1,031.8	935.9	894.6
Group	VII:	Ores and minerals	47.7	39.1	77.0	73.9	113.3	185.7	117.2	325.1
Group	VIII:	Iron ore, steel	1,330.7	2,296.9	1,559.0	1,862.4	1,771.1	1,811.8	1,549.0	1,501.6
Group	IX:	Feed and food products	113.2	177.4	218.9	192.1	223.2	305.8	563.2	770.9
Group	X:	Wood and paper products	106.3	110.5	124.1	101.3	74.4	66.4	95.1	42.5
Group	XI:	Petroleum products	165.0	167.5	90.8	141.4	88.7	110.7	84.7	140.6
Group	XII:	Rubber, plastics	165.8	225.6	249.4	222.0	332.3	273.2	219.0	383.1
Group	XIII:	Nonferrous metals	2.3	5.5	4.1	5.4	8.0	21.5	38.6	11.1
Group	XIV:	Manufactured products	134.7	153.2	242.5	98.8	69.5	55.6	103.2	103.8
Group	XV:	Other, nec.	1,522.1	2,182.6	2,240.4	2,101.0	2,574.6	3,694.2	3,267.8	3,534.5

Source: Compiled by RRNA from Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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Table 6. Ohio River System: Inbound Waterborne Commerce by Commodity Group, 1969-76

(Thousands of tons)

Group		1969	1970	1971	1972	1973	1974	1975	1976
Total:	All groups	20,706.8	23,182.7	24,755.7	24,713.5	25,387.4	28,372.0	26,713.2	29,439.5
Group I:	Coal and coke	7.8	98.9	246.6	835.4	1,279.2	1,943.4	2,774.1	2,632.2
Group II:	Petroleum fuels	6,721.5	7,411.5	7,611.4	7,970.3	8,735.8	9,256.6	8,751.5	8,814.8
Group III:	Crude petroleum	22.5	25.6	33.2	25.9	134.6	393.0	471.9	664.5
Group IV:	Aggregates	19.1	114.0	9.5	5.5	63.5	115.9	93.8	70.1
Group V:	Grains	2,532.8	2,823.7	2,919.3	1,912.6	1,740.0	1,742.3	1,368.1	1,418.0
Group VI:	Chemical, fertilizers	4,309.2	5,022.4	5,584.1	6,145.1	6,051.6	6,715.4	5,525.9	6,353.8
Group VII:	Ores and minerals	3,371.5	3,810.1	4,233.9	3,345.9	2,808.7	3,235.0	3,132.4	3,905.1
Group VIII:	Iron ore, steel	792.1	995.6	990.8	1,390.9	1,457.2	1,562.3	1,322.7	2,044.3
Group IX:	Feed and food products	289.3	351.4	378.8	380.6	338.0	405.9	458.4	458.7
Group X:	Wood and paper products	71.8	80.5	34.5	45.8	46.5	39.7	3.9	8.8
Group XI:	Petroleum products	1,743.8	1,797.2	1,842.1	1,819.5	2,061.0	2,206.4	1,955.9	2,016.7
Group XII:	Rubber, plastics	502.0	412.1	438.6	552.1	417.3	528.0	460.8	627.1
Group XIII:	Nonferrous metals	29.2	29.5	92.8	84.7	55.6	36.9	81.6	215.0
Group XIV:	Manufactured products	208.2	108.0	205.6	85.9	83.7	84.6	89.8	83.0
Group XV:	Other, nec.	96.0	102.2	134.5	113.3	114.7	106.6	219.4	127.4

Source: Compiled by RRNA from Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers

III. STUDY APPROACH AND METHODS

The traffic demand study of the Ohio River System consisted of two major tasks: first, the identification and analysis of historical commodity flows; and second, projections of future commodity flows. Included in these tasks were the assessment of historical and future market demands (consumption base) and resource inventories (production base) in the PSAs for each of the 15 commodity groups. Also, analysis of historical modal splits and transportation trends was a major component in the projection of future transportation patterns.

The initial step undertaken was the identification of those areas, within the ORB designated as Primary Study Areas (PSAs), which have been ultimate origins or destinations of waterborne movements. These PSAs are aggregations of counties, either BEAs or BEA segments. For most groups, waterside BEAs or BEA segments included all the ultimate ORB origins or destinations for ORS traffic. However, coal (Group I) and grains (Group V) are shipped considerable distances by rail and by truck to waterway transfer points along the waterway and then shipped by water. For these groups, the PSAs consist of both waterside and non-waterside BEAs and BEA segments. PSAs were identified and confirmed through field interviews and an extensive telephone survey of shippers and receivers.

For each of the 15 commodity groups, historical production and consumption, by PSA, either were obtained from published sources or were estimated. The sources of historical production and consumption data include the Bureau of Mines, U.S. Department of the Interior; the Economic Research Service and Statistical Reporting Service, U.S. Department of Agriculture; the Bureau of Economic Analysis and the Bureau of the Census, U.S. Department of Commerce; the U.S. Department of Energy; the U.S. Department of Transportation; and state agencies, such as state geological surveys, crop reporting services, and state commerce and transportation departments. In addition, data were provided by various local government agencies, as well as educational and research institutions in

the ORB. In many cases, county estimates were made by disaggregating existing national, regional, or state production/consumption estimates on the basis of such distribution factors as county employment, earnings, population, or production capacity. Many industry associations and individual commodity producers also were contacted.

Table 7 presents estimates of total production and consumption in the PSAs for each commodity group for the period, 1969-76. The sources and procedures used to determine production and consumption estimates are outlined in each of the commodity group reports. A general overview and explanation of procedures are contained in the methodology report.

Historical commodity movements to and from PSAs were estimated on the basis of waterborne and rail shipment data provided by the Corps of Engineers. Information regarding truck movements was inadequate to determine detailed (inbound, outbound and local) historical truck shipments. However, estimates of net truck shipments (outbound less inbound shipments) were derived from the commodity production and consumption estimates made for each PSA. Total net commodity shipments by PSA are equal to production minus consumption as well as being equal to the sum of net water, net rail and net truck. Thus, net truck shipments could be determined by subtracting net water and rail shipments from total net shipments.

Estimates of historical commodity production, consumption and shipments were analyzed to determine factors affecting modal choice, and to identify past trends and probable future changes in trends. Explicit consideration was given to the opinions and expert judgments of government agency staff members, shippers and receivers, and professional researchers associated with education and research institutions in the ORB. During the course of this investigation, more than 200 field interviews were conducted. In addition, approximately 400 telephone interviews were conducted.

Future production and consumption of commodity groups, by PSA, were projected for the years 1980, 1990, 2000, 2020 and 2040. These projections are presented in Table 8. They usually were based on existing national and regional projections developed by Federal agencies, and were disaggregated to PSA levels and adjusted on the basis of field research. A major aim of the projection methodology was to develop a set of projections for each commodity group that is consistent with all other commodity group projections. Thus, DOE projections were the basis of all energy-related commodities; the Bureau of Mines was the source of non-energy,

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Table 7. Ohio River Basin: Production, Consumption and Net Shipments by Commodity Group, Estimated 1969-76

(Thousands of tons unless otherwise specified)

Group		1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change 1969-76
Production:										
Group I:	Coal and coke[a]	419,206.0	446,265.0	397,707.0	418,883.0	411,747.0	406,863.0	429,228.0	436,998.0	0.6
Group II:	Petroleum fuels	14,096.3	13,880.4	13,680.8	14,076.1	14,570.0	15,156.8	16,376.9	15,841.7	1.7
Group III:	Crude petroleum	4,507.5	3,887.0	3,453.4	2,980.7	2,539.6	2,299.1	2,168.1	2,153.8	(10.0)
Group IV:	Aggregates	122,448.1	114,780.1	115,710.7	121,151.5	146,659.8	132,657.5	123,265.8	127,935.4	0.6
Group V:	Grains[b]	15,964.3	12,785.6	18,653.7	17,817.5	17,927.0	17,862.1	20,699.6	25,576.9	7.0
Group VI:	Chemicals, fertilizers	7,905.5	8,012.1	7,937.8	8,260.4	8,501.3	9,382.4	9,199.0	9,892.0	3.3
Group VII:	Ores and minerals[c]	124.5	118.3	119.3	101.7	64.2	85.7	83.0	82.5	(5.7)
Group VIII:	Iron ore, steel	78,248.8	72,553.8	68,329.2	76,308.1	86,082.8	84,478.6	62,527.3	67,721.4	(2.0)
Group IX:	Feed and food products[d]	3,051.8	3,087.5	3,117.0	3,125.0	3,149.6	3,175.3	3,170.8	3,208.6	0.7
Group X:	Wood and paper products[e]	4,833.1	4,945.2	5,048.2	5,340.0	5,469.2	5,842.0	5,490.7	5,788.4	2.6
Group XI:	Petroleum products[f]	980.9	984.9	1,050.7	1,028.1	1,092.1	1,102.2	988.8	1,026.9	0.7
Group XII:	Rubber, plastics[g]	4,048.0	3,607.0	3,979.0	4,232.0	4,491.0	4,400.0	3,794.0	4,215.0	0.6
Group XIII:	Nonferrous metals[h]	1,827.8	1,801.7	1,772.1	1,883.5	2,049.2	2,594.7	2,215.1	2,771.2	6.1
Group XIV:	Manufactured products[i]	7,163.4	7,150.3	6,553.6	6,965.7	7,533.8	8,023.0	7,214.7	7,449.0	0.6
Group XV:	Others, nec.	16,041.4	15,493.6	14,190.2	15,362.0	17,698.1	19,001.5	15,471.6	15,273.5	(0.7)
Total production		700,447.4	709,351.5	661,302.7	697,515.3	729,574.7	712,923.9	701,893.4	725,934.3	0.5
Consumption:										
Group I:	Coal and coke[a]	127,181.1	137,126.7	143,556.2	157,930.0	171,470.9	171,251.9	192,960.5	194,578.4	6.3
Group II:	Petroleum fuels	36,518.8	38,201.1	38,981.7	42,488.1	44,197.8	43,670.2	43,254.5	47,592.3	3.9
Group III:	Crude petroleum	1,370.7	1,210.6	1,252.5	1,403.9	1,589.3	1,602.5	1,707.9	1,880.2	4.6
Group IV:	Aggregates	122,292.2	116,350.8	119,068.4	126,646.8	152,898.0	137,926.3	127,829.3	132,319.2	1.1
Group V:	Grains[b]	23,459.3	24,706.7	23,906.1	23,215.7	23,315.5	22,287.7	21,950.6	22,081.5	(0.9)
Group VI:	Chemicals, fertilizers	8,672.1	9,705.1	10,501.9	10,901.6	11,711.9	13,895.5	12,605.8	15,263.2	8.4
Group VII:	Ores and minerals[c]	5,629.5	5,702.6	5,462.9	5,913.7	5,692.6	6,418.7	5,799.6	6,720.2	2.6
Group VIII:	Iron Ore, steel	104,188.5	96,025.6	88,638.5	99,845.2	111,092.8	108,882.0	82,458.1	89,416.1	(2.2)
Group IX:	Feed and food products[d]	5,068.3	5,261.8	5,038.7	4,999.9	5,025.6	4,972.8	4,769.1	4,864.3	(0.6)
Group X:	Wood and paper products[e]	11,019.0	11,232.0	11,971.7	12,836.9	11,860.6	14,365.0	13,701.0	13,247.6	2.7
Group XI:	Petroleum products[f]	2,724.2	2,784.5	2,751.9	2,908.3	3,231.7	2,827.3	2,671.0	2,883.7	0.8
Group XII:	Rubber, plastics[g]	7,711.5	7,170.7	7,475.2	7,624.4	8,118.7	7,890.1	6,607.5	7,313.9	(0.8)
Group XIII:	Nonferrous metals[g]	1,329.7	1,261.9	1,248.3	1,398.5	1,610.9	1,609.0	1,136.5	1,464.1	1.4

(Continued) --

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Table 7. (Continued)

Group	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change 1969-76
Consumption (Continued)									
Group XIV: Manufactured products[h]	3,690.1	3,898.4	4,111.4	4,523.3	5,053.1	5,521.1	5,860.2	6,546.8	8.5
Group XV: Others, nec.[i]	5,780.9	5,155.3	4,521.5	4,975.4	5,770.9	5,862.1	5,170.0	5,373.9	(1.0)
TOTAL CONSUMPTION	466,635.9	465,793.8	468,486.9	507,611.8	562,640.3	548,982.2	528,481.6	551,545.4	2.4
Net Shipments[j]	233,811.5	243,558.7	192,815.8	189,903.5	166,934.4	163,941.7	173,411.8	174,388.9	(4.1)

Note: Production and consumption estimates are for areas in the ORB defined as origins and destinations of waterborne movements. The definition of areas varies by group.

a. Includes coal only.
b. Includes corn, wheat and soybeans only. Corn is corn for grain. Wheat is all wheat. Soybeans are soybeans for beans.
c. Includes manganese, liquid sulfur, rock salt, zinc ore and alumina.
d. Includes lumber products, pulpwood logs and paper products.
e. Includes lubricating oils and greases, naphtas and asphalt.
f. Includes lime and portland cement.
g. Includes the primary metal of aluminum, copper, lead, zinc, nickel, titanium, magnesium, tin, antimony, beryllium, choromium, manganese and cadmium and primary products of aluminum, copper and molybdenum.
h. Includes fabricated metal products, machinery products, electrical machinery products, and ships and boats.
i. Includes petroleum and coal products, nec.; slags; and waterway improvement and government materials.
j. Total production minus total consumption.

Source: Robert R. Nathan Associates, Inc.

Table 8. Ohio River Basin: Production, Consumption and Net Shipments by Commodity Group, Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

Group		Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Production:									
Group I:	Coal and coke[a]	436,998.0	481,431.0	627,200.0	736,547.5	931,672.6	1,136,818.3	2.2	1.1
Group II:	Petroleum fuels	15,841.7	18,162.3	24,509.0	22,916.0	17,530.7	10,202.9	1.6	(2.0)
Group III:	Crude petroleum	2,153.8	2,097.6	2,041.9	1,846.7	1,232.9	554.9	(0.6)	(3.0)
Group IV:	Aggregates	127,935.4	135,611.3	156,594.4	172,248.3	204,570.7	222,546.3	1.3	0.6
Group V:	Grains[b]	25,576.9	19,859.7	25,199.4	32,549.6	39,361.2	46,719.5	1.0	0.9
Group VI:	Chemicals, fertilizers	9,892.0	11,964.9	16,974.5	24,068.3	43,398.8	58,506.7	3.8	2.3
Group VII:	Ores and minerals[c]	82.5	88.8	119.3	178.6	296.1	490.9	3.3	2.6
Group VIII:	Iron ore, steel	67,721.4	75,252.9	76,421.9	84,765.1	107,434.2	123,200.6	0.9	0.9
Group IX:	Feed and food products	3,208.6	4,252.6	5,099.0	6,082.0	8,462.0	10,035.0	2.7	1.3
Group X:	Wood and paper products[d]	5,788.3	6,922.7	9,049.7	11,407.6	16,796.1	20,808.0	2.9	1.5
Group XI:	Petroleum products[e]	1,026.9	1,918.7	2,272.2	2,124.5	1,625.3	945.9	3.1	(2.0)
Group XII:	Rubber, plastics[f]	4,215.0	6,047.0	8,562.0	10,520.0	12,428.0	13,545.0	3.9	0.6
Group XIII:	Nonferrous metals[g]	2,771.2	3,610.4	6,692.4	9,909.1	18,407.2	25,236.1	5.5	2.4
Group XIV:	Manufactured products[h]	7,449.0	9,905.0	14,252.3	20,061.1	35,621.5	47,984.3	4.2	2.2
Group XV:	Others, nec.[i]	15,273.5	17,061.7	15,425.4	16,253.8	18,661.7	20,685.4	0.3	0.6
Total production		725,934.2	794,186.6	990,413.4	1,151,478.2	1,457,499.0	1,738,279.8	1.9	1.0
Consumption:									
Group I:	Coal and coke[a]	194,578.4	216,792.8	268,856.5	334,826.2	465,257.4	606,624.0	2.3	1.5
Group II:	Petroleum fuels	47,592.3	48,895.8	59,621.3	64,826.8	54,249.3	38,188.3	1.3	(1.3)
Group III:	Crude petroleum	1,880.2	2,663.1	2,015.1	1,804.1	1,441.3	838.8	k	(2.0)
Group IV:	Aggregates	132,319.2	139,680.5	161,785.4	178,855.8	211,523.6	229,685.8	1.3	0.6
Group V:	Grains[b]	22,081.5	22,352.2	23,323.4	25,139.0	26,104.0	27,102.8	0.5	0.2
Group VI:	Chemicals, fertilizers	15,263.2	16,140.5	22,250.3	30,725.2	52,342.8	69,231.6	3.0	2.1
Group VII:	Ores and minerals[c]	6,720.2	8,289.3	13,503.2	18,987.9	33,076.4	45,664.3	4.4	2.2
Group VIII:	Iron ore, steel	89,416.1	100,662.6	101,286.0	116,005.2	155,314.8	183,544.2	1.1	1.2
Group IX:	Feed and food products	4,864.3	5,218.0	6,075.6	7,155.5	9,420.7	10,930.6	1.6	1.1
Group X:	Wood and paper products[d]	13,247.5	15,811.4	22,971.2	29,984.7	45,873.4	58,779.1	3.5	1.7
Group XI:	Petroleum products[e]	2,883.7	3,326.2	4,882.1	5,308.6	4,442.1	3,126.8	2.6	(1.3)
Group XII:	Rubber, plastic[f]	7,313.9	11,429.7	16,677.5	19,942.2	25,044.2	28,511.3	4.3	0.9
Group XIII:	Nonferrous metals[g]	1,464.9	1,814.0	2,681.2	3,575.9	6,050.3	7,893.2	3.8	2.0
Group XIV:	Manufactured products[h]	6,546.8	7,393.1	10,419.7	14,653.7	26,469.2	35,925.7	3.4	2.3
Group XV:	Others, nec.[i]	5,373.9	5,922.4	6,051.5	6,557.3	7,615.9	8,169.5	0.8	0.6
Total consumption		551,546.1	606,391.6	722,400.0	858,428.1	1,124,225.4	1,354,216.0	1.9	1.2
Net shipments[j]		174,388.1	187,795.0	268,013.4	293,050.1	333,273.6	384,063.8	2.2	0.7

Note: Production and consumption estimates are for areas in the ORB defined as origins and destinations of waterborne movements. The definition of areas varies by group.

a. Includes coal only.

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Table 8. (Continued)

b. Includes corn, wheat and soybeans only. Corn is corn for grain. Wheat is all wheat. Soybeans are soybeans for beans.
c. Includes manganese, liquid sulfur, rock salt, zinc ore and alumina.
d. Includes lumber products, pulpwood logs and paper products.
e. Includes lubricating oils and greases, naphtas and asphalt.
f. Includes lime and portland cement.
g. Includes the primary metal of aluminum, copper, lead, zinc, nickel, titanium, magnesium, tin, antimony, beryllium, choromium, manganese and cadmium and primary products of aluminum, copper and molybdenum.
h. Includes fabricated metal products, machinery products, electrical machinery products, and ships and boats.
i. Includes petroleum and coal products, nec.; slags; and waterway improvement and government materials.
j. Total production minum total consumption.
k. Less than + 0.01 percent growth.
Source: Robert R. Nathan Associates, Inc.

nonferrous mineral and ore projections; the U.S. Department of Agriculture was the source of grains projections, as well as some components of chemical fertilizer and feed and food product projections; and projections of economic activity by industry by the Bureau of Economic Analysis for OBERS Projections were used for the remaining commodities. Table 9 summarizes the methods and sources used to project future production and consumption levels.

Projections of a commodity group, or of a commodity within a group, were often used as a basis for projecting other commodity groups. Thus, projections of iron and steel production were the basis for projections of metallurgical coal consumption and the projections of lime used as flux in the production of steel. Specific sources and procedures used in the projections of the production and consumption of commodity groups and individual commodities are listed in the individual commodity group reports. Table 10 illustrates these interrelationships.

Projections of commodity shipments, receipts and modal splits were based on projections of production and consumption, by PSA, on 1976 traffic patterns and on past trends. Adjustments were made to reflect the judgments of industry experts and the stated intentions of individual firms. The 1976 waterborne traffic movements were verified through an extensive survey performed for the Corps of Engineers. Waterborne commerce data for earlier years were less reliable, thereby requiring relatively heavy reliance on interviews with industrial shippers and receivers to identify past shifts in trends.

Projections of waterborne shipments and receipts were distributed among BEA-to-BEA links on the basis of historical (1976) distributions, adjusted according to information acquired through interviews conducted during the course of the study. For each BEA-to-BEA link, further distributions were made among PE links. These distributions also were based on historical (1976) distributions. When industry sources indicated likely future shifts in the historical distribution among PE-to-PE links, appropriate adjustments were made.

Table 9. Ohio River Basin Study: Summary of Methodology for the Projection of Production and Consumption, by Commodity Group

Commodity group	Production	Consumption
Coal and coke	Projected production for 1980 and 1990 was derived from U.S. Department of Energy, Annual Report to Congress, Appendix to Volume II, regional projections. Tonnages for 2000-2040 were derived from growth rate projections of ICF, "Summary of Forecasts of ICF's Coal and Electric Utility Model for the Energy Modeling Forum" in Coal In Transition, 1978.	Electric utility consumption projections for 1980 and 1990 were derived from U.S. Department from Energy, "Appendix," Annual Report to Congress, Vol. II and from Oak Ridge National Laboratory estimates in Energy Availabilities for State and Local Development, 1978, adjusted in some BEAs on the basis of interviews with specific utilities. Electric utility consumption projections in the later years were based either on growth rates in personal income or on the operation plans of individual utilities. BEA growth rates were obtained from OBERS Projections. Tonnages for use in coke manufacture were projected using projections of pig iron production. Tonnages of other consumption were based on regional DOE projections of growth rates of non-metallurgical industrial use, and disaggregated and projected in a similar matter as electric utility consumption.
Petroleum fuels	The production estimates for each PSA were computed by multiplying the 1976 estimates by the appropriate growth rates of crude petroleum consumption from Crude Petroleum (Group III)-Report.	The consumption of petroleum fuels for 1980 was projected based on the annual growth rates of the BEAs for the 1977-80 period, available from Oak Ridge National Laboratory, Energy Availabilities for State and Local Development: Projected Energy Patterns for 1980 and 1985, adjusted on the basis of projections made by the U.S. Department of Energy (DOE), Annual Report to Congress, Vol. II, 1977 ed. The 1990 and 2000 projections were derived from the national consumption estimates of DOE and distributed to BEAs. The rates of consumption change in the later decades were assumed to be two-thirds of the rates in change in petroleum fuel production.
Crude petroleum	The production of crude petroleum for 1980 was projected based on the average annual growth rates of the BEAs for the 1977-80 period available from Oak Ridge National Laboratory, Energy	The consumption of crude petroleum for 1980 was based on the average annual growth rate of the BEAs for 1974-80 period available from Oak Ridge National Laboratory, Energy Availabilities for

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Table 9. (Continued)

Commodity group	Production	Consumption
	Availabilities for State and Local Development: Projected Energy Patterns for 1980 and 1985, adjusted on the basis of projections made by the U.S. Department of Energy (DOE). The 1990 projections are derived from the national production estimates of DOE in Annual Report to Congress, Vol. II, 1977 ed. and distributed to BEAs by 1985 allocation factors provided by Oak Ridge. For post 1990 decades, the rate of decrease in crude oil production is assumed to be twice that of the preceding period.	1980 and 1985, adjusted on the basis of projections made by the U.S. Department of Energy (DOE). The 1980 projections were derived from the national consumption estimates of DOE and distributed to the BEAs by 1985 allocation factors provided by Oak Ridge. For post 1990 decades, the rates of consumption change were assumed to be two-thirds of the rate of change in crude oil production.
Aggregates	Production was assumed to be equal to consumption plus net shipments. Total PSAs' waterborne receipts were projected as a proportion of total PSA projected consumption. Projection of outbound and inbound traffic was based on historical patterns and field information. Total PSAs' shipments were allocated among PSAs according to distribution of reserves of material. Projections of net rail shipments were assumed to be equal to a constant proportion of total consumption.	Consumption of flux by PSA was projected by applying ratio of flux per ton of iron and steel manufactured to RRNA projections of iron and steel production and furnace type from the Iron and Steel (Group VIII) Report. Consumption of crushed rock by the cement and lime industries by PSA was derived from RRNA projections of cement and lime production from the Rubber, Plastic and Nonmetallic Minerals, Nec. (Group XII) Report. Projected consumption of construction aggregates was obtained by projecting per capita consumption of aggregates by PSA and applying to population projections by PSA. Population projections were obtained from U.S. Water Resources Council, OBERS Projections.
Grains	State level projections of grain production to 2000 were provided by U.S. Department of Agriculture, Economic Research Service, USDA National Interregional Agricultural Projections (NIRAP) System. RRNA projected grain production to 2040 at the state level for corn, wheat and soybean. For each PSA, the percentage of the respective state's total grain production (1969-76) was estimated and then projected into the future using trend analysis in conjunction with expert judgment. The percent of each state's total grain production allocated to each PSA by period (1980 to 2040) was multiplied by state projections to estimate grain production in each PSA.	State level projections of livestock production, by livestock category, to 2000 was provided by U.S. Department of Agriculture, Economic Research Service, USDA National Interregional Agricultural Projections (NIRAP) System. Livestock production projections to 2040 were projected by RRNA. For For each PSA, the percentage of the respective state's total livestock production (1969-76) was estimated and then projected using trend analysis, in conjunction with expert judgment. The percent of each state's total livestock production allocated to each PSA was multiplied by state projections to estimate livestock production in each PSA.

(Continued) --

Table 9. (Continued)

Commodity group	Production	Consumption
Chemicals and chemical fertilizers	The growth rates of earnings in the chemical and allied products industry from OBERS Projections, were used to project production for 1980-2020. Production between 2020 and 2040 was assumed to increase at an average annual rate equal to half the growth rates projected for the period 2000-2040.	The growth rates by BEA of consuming industries from OBERS Projections for the period 1980-2020 were used to project industrial chemical consumption for 1980-2020. The growth in industrial chemical consumption between 2020 and 2040 was equal to half the growth rates projected for the period 2000-2020. Projected agricultural chemical consumption was derived by multiplying fertilizer application rates by acreage. Projected acreage was obtained from Grains (Group V) Report.
Ores and minerals	Growth rates for U.S. mine production of zinc from U.S. Bureau of Mines, Mineral Facts and Problems, were applied to RRNA estimates of zinc ore production for 1976.	Consumption of aluminum ores and concentrates, zinc ore and concentrates, mangenese ore and sulfur were projected by applying appropriate factors to RRNA projections of specific commodities. The growth rates for rock salt consumption were based on interviews with industry officials and on U.S. Bureau of Mines, "Salt," Minerals Facts and Problems, 1975.
Iron ore, steel, and iron	Production of pig iron was based upon RRNA estimates of pig iron consumption and interviews with steel industry officials. Production of steel mill products, ferroalloys, and ferrous casting was based on OBERS Projections. Certain adjustments to OBERS based on interviews with industry sources and U.S. Bureau of Mines official. Factors relating home scrap production to raw steel production from Institute of Scrap Iron and Steel, Facts, were used to forecast home scrap production.	Consumption of iron ore and concentrates, pig iron, ferroalloys ferrous castings and iron and steel scrap was projected by applying appropriate factors to RRNA projections of specific commodities. These growth rates of earnings in specific industries from OBERS Projections were used to project consumption of steel mill products.
Food and feed products	The growth rate of earnings in the food and kindred products industry from OBERS Projections were used to project the production of food and feed products for 1980-2020. Production for 2020-2040 was assumed to increase at an average annual rate equal to half the growth rates for 2000-2020.	Consumption of food and feed products were projected based on the growth rate of earnings in the food and kindred products industry from OBERS Projections and growth rate of corn consumption by livestock from grains (Group V) Report. Consumption for 2020-2040 was assumed to increase at an average annual rate equal to half the growth rates projected for 2000-2020.
Wood and paper products	Projected production of wood and paper products form 1980-2020 were based on growth rates of earnings from OBERS Projections and U.S. Bureau of Economic Analysis data on file. Production for 2020-2040 was assumed to increase at an average annual rate equal to one-half the growth rates for 2000-2020	Projected consumption of wood and paper products for 1980-2020 were based on growth rates of earnings from OBERS Projections and U.S. Bureau of Economic Analysis data on file. Projected consumption for 2020-2040 was assumed to increase at an average annual rate equal to one-half the growth rates for 2000-2020.

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Table 9. (Continued)

Commodity group	Production	Consumption
Petroleum products, nec.	Projections of petroleum products production were derived by applying the growth rates of petroleum fuels (Group II) production to the 1976 estimates of petroleum products production and were based on discussion with industrial authorities.	The 1980 and 1990 projections were estimated by computing the average annual growth rates of consumption of "other hydro-carbons" from Oak Ridge National Laboratory, Energy Availabilities for State and Local Development: Projected Energy Patterns for 1980 and 1985. For the post 1990 years, the consumption of petroleum products is assumed to grow at the same rate as the consumption of petroleum fuels.
Rubber, plastic, non-metallic mineral products, nec.	Portland cement production and lime production were assumed to increase at the same rate as projected consumption of portland cement and and projected consumption of lime. Certain adjustments were made on the basis of unpublished data available from U.S. Bureau of Mines.	Projected consumption of portland cement was derived from estimated state per capita consumption in future years and projected county population from OBERS Projections. Projected consumption of lime by the steel industry and the chemical industry was estimated from RRNA projection of steel production and chemical production. Projected consumption of lime by desulphurization use was estimated for planned lime/limestone flux gas desulphurization (FGD) installation processes from Environmental Protection Agency, Flue Gas Desulphurization in Power Plants Status Report.
Nonferrous metals and alloys, nec.	Projections of nonferrous metals and alloys production were derived by applying the growth rates of the primary metal industry (measured by real earnings) to the 1976 estimates of nonferrous metals and alloys. Production for 2020-2040 was projected to increase at an average annual rate equal to half the rate projected for 2000-2020.	Projected consumption of nonferrous metals and alloys was derived by applying the growth rates of the primary metal industry to the estimate of 1976 consumption for 1980-2020. Consumption for 1980-2020 was projected to increase at an average annual rate equal to half the rate projected for 2000-2020.
Manufacted products, nec.	Projections of production of selected manufactured products were derived from the appropriate industrial growth rate in earnings from OBERS Projections applied to 1974-76 average production. Production for 2020-2040 was projected to increase at an average annual rate equal to half the projected growth rate for 2000-2040.	Projected consumption for 1980-2020 was derived from average annual growth rates of total earnings from OBERS Projections applied to actual average 1974-76 consumption. Consumption for 2020-2040 was projected to increase at an average annual rate equal to half the projected growth rate for 2020-2040.

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Table 9. (Continued)

Commodity group	Production	Consumption
Others, nec.	Production of petroleum products, nec. was projected based on the projected crude oil consumption from crude petroleum (Group III) report. Production of coal products was projected based on coal consumed in coke plants from Coal (Group I) Report. Production of iron slag and steel slag was projected based on RRNA projection of pig iron production and steel production by open hearth and basic oxygen furnaces from Iron Ore, Steel and Iron (Group VIII) Report. Production of waterway improvement material in 1980 was based on the weighted average of growth rates of consumption in appropriate river and BEA destinations. Production in later years was assumed to approximate the 1980 level.	Projected consumption of petroleum products was based on the growth rates of consumption of petroleum products, nec. (Group XI). Consumption of coal products was assumed to be equal to production. Projected consumption of slag, iron and steel products was based on the projected steel production Group VIII. The consumption of waterway improvement materials for 1980 was based on the rate of growth of the COE budget on river maintenance and bank stabilization by river. For post 1980 years, consumption of waterway improvement materials was assumed to remain at the 1980 level.

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Table 10. Ohio River Basin Study: Interrelationships of Projections

Source		Result	
Group	Commodity/Product	Used in the projection of: Commodity/Product	Group
I.	Production of coke	Production of coal products	XV
III.	Consumption of crude petroleum	Production of petroleum fuels	II
III.	Consumption of crude petroleum	Production of other petroleum products, nec.	XV
V.	Consumption of corn by livestock	Consumption of food and feed products by livestock	IX
V.	Harvested acreage	Consumption of fertilizer	VI
VI.	Production of chemicals and chemical fertilizers	Consumption of sulfur	VII
VI.	Production of chemicals and chemical vertilizers	Consumption of lime by the chemical industry	XII
VIII.	Production of pig iron	Consumption of coke by the steel industry	I
VIII.	Production of pig iron	Production of iron slag	XV
VIII.	Production of steel	Consumption of coal products	XV
VIII.	Production of steel	Consumption of lime by steel industry	XII
VIII.	Production of steel	Consumption of aggregates by steel industry	IV
VIII.	Production of steel	Consumption of manganese ore	VII
XII.	Production of lime and cement	Consumption of aggregates by lime and cement industries	IV
XIII.	Production of primary zinc	Consumption of zinc ore	VII
XIII.	Production of aluminum	Consumption of aluminum ores	VII

Source: Robert R. Nathan Associates, Inc.

IV. STUDY FINDINGS AND CONCLUSIONS

Through the year 2000, total ORS waterborne commerce is expected to have an average annual increase of 2.2 percent (Table 11). This rate of increase will decline during the period 2000-2040, when an average annual increase of only 0.7 percent is expected.

Traffic in ores and minerals is projected to have the highest rate of future change, closely followed by nonferrous metals and alloys, nec., and manufactured products, nec. Most of the increases in ores and minerals are projected to be inbound movements. Of the 15 groups, Ohio River Basin consumption of ores and minerals is projected to increase at the most rapid rate, thereby prompting these movements. The growth in ore and mineral consumption is primarily due to increased demand for alumina.

The growth in nonferrous metals and alloys ORS waterborne movements is expected to be the result of increased production in the ORB. Of the 15 commodity groups, the production of nonferrous metals and alloys is expected to increase most rapidly, prompting increases in outbound shipments. Of the nonferrous metals, primary aluminum metal, aluminum mill and foundry products will account for most of the increase in Group VII production.

While waterborne movements of most commodity groups are projected to increase during the projection period, movements of petroleum-related groups (Group II -- petroleum fuels, Group III -- crude petroleum, Group XI -- petroleum products, nec.) are projected to decline, as are the production and consumption of these groups.

Total inbound waterborne shipments to the ORS are projected to increase at an average annual rate of 3.1 percent through 2000, and at an average annual rate of 1.8 percent between 2000 and 2040 (Table 12). A significant portion of this increase will result from increases in inbound shipments of coal (although most coal shipments will continue to be local).

Table 11. Ohio River System: Total Waterborne Commerce by Commodity Group, Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

		Estimated	Projected					Average annual percentage change	
		1976	1980	1990	2000	2020	2040	1976-2000	2000-2040
Total: All groups		200,770.5	222,160.5	297,291.4	334,307.5	390,772.1	438,742.8	2.2	0.7
Group I:	Coal and coke	116,532.9	130,390.6	183,495.7	204,160.8	228,100.2	253,656.9	3.3	1.2
Group II:	Petroleum fuels	20,943.4	21,166.2	27,179.1	28,299.8	22,627.0	15,806.8	1.3	(1.5)
Group III:	Crude petroleum	664.5	847.0	826.8	772.8	591.2	344.2	0.6	(2.0)
Group IV:	Aggregates	25,152.3	27,554.0	30,140.2	31,363.7	37,092.2	40,276.0	0.9	0.6
Group V:	Grains	5,582.0	4,153.5	4,996.6	6,043.0	7,275.0	8,637.4	0.3	0.9
Group VI:	Chemicals and chemical fertilizers	11,364.0	12,396.0	16,533.7	22,419.6	37,564.8	49,195.3	2.9	2.0
Group VII:	Ores and minerals	4,451.0	5,413.1	8,490.6	11,814.7	20,198.1	28,405.2	4.2	2.2
Group VIII:	Iron ore, steel and iron	5,063.9	6,364.9	7,664.7	9,435.9	14,324.0	18,123.9	2.6	1.7
Group IX:	Food and feed products, nec.	1,267.4	1,584.9	1,758.9	2,055.9	2,875.1	3,399.1	2.0	1.3
Group X:	Wood and paper products	566.6	558.2	739.8	885.6	1,191.1	1,432.3	1.9	1.2
Group XI:	Petroleum products, nec.	2,793.3	3,530.4	5,601.1	6,062.7	5,058.4	3,518.8	3.3	(1.4)
Group XII:	Rubber, plastic, nonmetallic mineral products, nec.	1,471.3	2,573.0	3,980.5	4,588.7	6,031.9	7,020.1	4.9	1.1
Group XIII:	Nonferrous metals and alloys, nec.	246.9	308.6	468.2	633.1	1,138.7	1,567.8	4.0	2.3
Group XIV:	Manufactured products, nec.	351.6	508.7	701.8	970.1	1,665.8	2,216.3	4.3	2.1
Group XV:	Others, nec.	4,319.4	4,811.4	4,713.7	4,801.1	5,038.6	5,142.7	0.4	0.2

Source: Robert R. Nathan Associates, Inc.

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Table 12. Ohio River System: Inbound Waterborne Commerce by Commodity Group, Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

		Estimated	Projected					Average annual percentage change	
		1976	1980	1990	2000	2020	2040	1976-2000	2000-2040
Total:	All groups	29,439.5	29,722.2	45,770.5	61,239.4	93,591.7	122,576.4	3.1	1.8
Group I:	Coal and coke[a]	2,632.2	3,208.6	12,982.1	17,385.5	32,387.5	47,141.2	8.2	4.5
Group II:	Petroleum fuels	8,814.8	5,939.3	4,874.9	8,240.8	7,650.4	7,314.8	(0.3)	(0.3)
Group III:	Crude petroleum	664.5	847.0	826.8	772.8	591.2	344.2	0.6	(2.0)
Group IV:	Aggregates	70.1	74.0	85.7	94.7	112.0	121.7	1.3	0.6
Group V:	Grains	1,418.0	1,473.9	1,389.1	1,211.7	1,118.3	1,018.8	(0.7)	(0.4)
Group VI:	Chemicals and chemical fertilizers	6,353.8	6,341.0	8,078.8	10,540.3	16,406.7	20,852.8	2.1	1.7
Group VII:	Ores and minerals	3,905.1	4,774.0	7,547.7	10,483.3	17,947.9	25,115.1	4.2	2.2
Group VIII:	Iron ore, steel and iron	2,044.3	2,769.4	3,708.6	4,979.1	8,526.6	11,355.0	3.8	2.1
Group IX:	Food and feed products, nec.	458.7	495.4	464.6	543.8	739.8	866.1	0.7	1.2
Group X:	Wood and paper products	8.8	7.2	13.8	16.8	28.0	38.1	2.7	2.1
Group XI:	Petroleum products, nec.	2,016.7	2,044.9	3,453.4	3,977.1	3,429.7	2,544.6	2.9	(1.1)
Group XII:	Rubber, plastic, nonmetallic mineral products, nec.	627.1	1,018.9	1,567.6	1,958.2	2,880.3	3,575.5	4.9	1.5
Group XIII:	Nonferrous metals and alloys, nec.	215.0	257.9	382.0	509.9	916.6	1,255.4	3.7	2.3
Group XIV:	Manufactured products, nec.	83.0	90.1	117.0	155.9	259.2	334.7	2.7	1.9
Group XV:	Others, nec.	127.4	380.6	278.4	369.5	597.5	698.4	4.5	1.6

a. Includes shipments which originated from BEAs outside the ORB via rail and were transloaded onto barges within the ORS. The total movement is inbound to the ORB.

Source: Robert R. Nathan Associates, Inc.

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Total outbound waterborne shipments from the ORS are projected to increase at an average annual rate of 2.3 percent between 1976 and 2000, and then to remain at a fairly stable level (Table 13). The level of outbound shipments between 2000 and 2040 in three groups (Groups I, II and XI) are expected to decrease, but most of these decreases will be offset by increases in the other groups.

Local waterborne shipments within the ORS are expected to increase from 144.5 million tons in 1976 to 271.1 million tons in 2040. Most of this increase will be in local coal traffic, which is projected to increase by 92 million tons during the period (Table 14).

In the following sections, findings of each of the 15 commodity group studies are summarized. Discussion of production and consumption is centered on trends in the PSAs of each group and the impacts on waterborne transportation in the ORS. Historical and future estimates of production and consumption levels, by BEA and by commodity group, are presented in the appendices, as are the BEA-to-BEA flows for each group. Also contained in the appendices are projections of commodity flows through each of the lock and dams within the ORS.

A. Coal and Coke

Group I, coal and coke, consists of various grades and types of coal, as well as coke, a semi-refined product made from coal. As the most important commodity group moving in the Ohio River System (ORS), Group I accounted for 58 percent of all waterborne traffic in the ORS in 1976.

The individual commodities and products included in Group I are:

Waterborne Commerce Statistics Code (WCSC)	Commodity/Product
1121	Coal and lignite
2920	Coke, including petroleum coke

Table 13. Ohio River System: Outbound Waterborne Commerce by Commodity Group, Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

		Estimated	Projected					Average annual percentage change	
		1976	1980	1990	2000	2020	2040	1976-2000	2000-2040
Total: All groups		26,854.0	26,765.2	40,445.8	46,120.8	43,272.8	45,108.9	2.3	(0.1)
Group I:	Coal and coke	12,552.7	11,140.9	22,274.4	24,328.0	16,297.5	13,[illegible].5	4.2	(1.6)
Group II:	Petroleum fuels	1,293.1	1,589.6	1,543.1	2,176.4	1,534.1	1,695.2	2.2	(0.6)
Group III:	Crude petroleum	--	--	--	--	--	--	--	--
Group IV:	Aggregates	1,265.4	2,412.2	2,638.4	2,745.3	3,246.4	3,525.4	3.3	0.6
Group V:	Grains	4,035.0	2,593.5	3,492.6	4,674.6	5,957.5	7,372.6	0.6	1.2
Group VI:	Chemicals and chemical fertilizers	894.6	1,074.9	1,471.5	2,047.6	3,613.4	4,822.4	3.5	2.2
Group VII:	Ores and minerals	325.1	377.6	572.3	838.5	1,457.2	2,197.8	4.0	2.4
Group VIII:	Iron ore, steel and iron	1,501.6	1,782.1	1,934.0	2,171.4	2,818.0	3,294.1	1.6	1.1
Group IX:	Food and feed products, nec.	770.9	1,045.5	1,242.9	1,444.3	2,051.2	2,432.3	2.7	1.3
Group X:	Wood and paper products	42.5	43.8	80.3	117.2	184.4	229.2	4.6	1.7
Group XI:	Petroleum products, nec.	140.6	201.5	318.1	335.1	275.6	188.0	3.7	(1.4)
Group XII:	Rubber, plastic, nonmetallic mineral products, nec.	383.1	518.1	735.4	917.2	1,037.9	1,106.0	3.7	0.5
Group XIII:	Nonferrous metals and alloys, nec.	11.1	20.7	37.3	58.7	112.6	167.7	7.2	2.7
Group XIV:	Manufactured products, nec.	103.8	222.6	347.8	520.3	968.8	1,352.5	7.0	2.4
Group XV:	Others, nec.	3,534.5	3,742.2	3,757.7	3,746.2	3,718.2	3,684.2	0.2	a

Source: Robert R. Nathan Associates, Inc.

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Table 14. Ohio River System: Local Waterborne Commerce by Commodity Group, Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

		Estimated	Projected					Average annual percentage change	
		1976	1980	1990	2000	2020	2040	1976-2000	2000-2040
Total: All groups		144,477.0	165,673.4	211,075.2	226,947.3	253,907.6	271,057.5	1.9	0.5
Group I:	Coal and coke	101,348.0	116,041.1	148,239.2	162,447.3	179,415.2	193,474.2	2.0	1.0
Group II:	Petroleum fuels	10,835.5	13,637.3	20,761.1	17,882.6	13,442.5	6,796.8	2.1	(2.4)
Group III:	Crude petroleum	--	--	--	--	--	--	--	--
Group IV:	Aggregates	23,816.8	25,067.8	27,416.1	28,523.7	33,733.8	36,628.9	0.8	0.6
Group V:	Grains	129.0	86.1	114.9	156.7	199.2	246.0	0.8	1.2
Group VI:	Chemicals and chemical fertilizers	4,115.6	4,980.1	6,983.4	9,831.7	17,544.7	23,520.1	3.7	2.2
Group VII:	Ores and minerals	220.8	261.5	370.7	492.9	793.0	1,092.3	3.4	2.0
Group VIII:	Iron ore, steel and iron	1,518.0	1,813.4	2,022.1	2,285.4	2,979.4	3,474.8	1.7	1.1
Group IX:	Food and feed products, nec.	37.8	44.0	51.4	67.8	84.1	100.7	2.5	1.0
Group X:	Wood and paper products	515.3	507.2	645.7	751.6	978.7	1,165.0	1.6	1.1
Group XI:	Petroleum products, nec.	636.0	1,284.0	1,829.6	1,750.5	1,353.1	786.2	4.3	(2.0)
Group XII:	Rubber, plastic, nonmetallic mineral products, nec.	461.1	1,036.0	1,677.5	1,713.3	2,113.7	2,338.6	5.6	0.8
Group XIII:	Nonferrous metals and alloys, nec.	20.8	30.0	48.9	64.5	109.5	144.7	4.8	2.0
Group XIV:	Manufactured products, nec.	164.8	196.0	237.0	293.9	437.8	529.1	2.4	1.5
Group XV:	Others, nec.	657.5	688.9	677.6	685.4	722.9	760.1	0.2	0.3

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

3313 Coke (coal and petroleum pitches and asphalts, naphtha and solvents)

Coal and lignite (WCSC 1121) accounted for almost all of the waterborne Group I movements. In the ORS hinterland, coke is generally used at the site of production or is transported via rail to its location of use. Therefore, coke (WCSC 2920) accounted for only 477.5 thousand tons, or less than 1 percent of Group I waterborne movements in 1976. The products in WCSC category 3313 are foreign trade elements of coal and coke. There were no recorded movements of these products in the ORS during the 1969-76 period. No movements of WCSC 3313 products are expected in the future.

Between 1969 and 1976, local movements accounted for between 85 and 88 percent of Group I waterborne traffic in the ORS. Local waterborne Group I traffic increased from 77.1 million tons in 1969 to 101.3 million tons in 1976, an average annual increase of 4.0 percent. Inbound and outbound waterborne movements of Group I commodities exhibited a slightly different pattern. Inbound waterborne Group I shipments increased dramatically, growing from 7.8 thousand tons in 1969 to 2.6 million tons in 1976. However, inbound shipments represented less than 3 percent of Group I waterborne movements. Outbound shipments increased from 9.9 million tons in 1969 to 12.6 million tons in 1976, an average annual increase of 3.5 percent. Outbound shipments accounted for between 10 and 13 percent of Group I waterborne shipments in the 1969-76 period.

The largest shippers of waterborne Group I movements in the ORS hinterland in 1976 were BEAs 66 (Pittsburgh), 65 (Clarksburg), 55 (Evansville) and 52 (Huntington). Together, these BEAs accounted for 88 percent of all Group I waterborne shipments. Most shipments were made to destination points close to, or actually in, the BEAs of their origination.

Coal and lignite have three major uses as inputs into the production of other products. The primary use of coal, accounting for approximately three-fourths of domestic coal consumption, is as an input to the production of electricity. Metallurgical usages of coal include the production of coke for pig iron production, the manufacture of calcium carbide, the reduction of ferroalloys, nonferrous smelting and processing and the burning of lime. These

usages account for approximately 15 percent of domestic coal consumption. The remaining 10 percent of coal is consumed by such uses as private electricity-generation, railroad and bunker fuel, space heating, and various industrial processes.

The consumption of coal in the PSAs increased at an average annual rate of 6.3 percent during the period 1969-76, from 127.1 million tons in 1969 to 194.6 million tons in 1976. This growth was stimulated almost entirely by the increased consumption of coal by electric utilities and industrial users. Consumption of metallurgical coal by coke plants decreased during the period because of underutilization of capacity in the iron and steel industry. Other consumption of coal showed only moderate increases.

Coal consumption by the electric utilities in the PSAs increased at a rate of 7.7 percent during 1969-76. In 1976, the PSAs accounted for over 37 percent of the coal used by the electrical utility industry in the United States. This was up from approximately 23 percent in 1969. In terms of the absolute quantities of steam coal consumed, BEA 66 (Pittsburgh) was by far the largest in 1976. Second in the consumption of coal in electricity generation was BEA 52 (Huntington). BEAs 62 (Cincinnati) and 55 (Evansville) were also substantial consumers of steam coal. The largest consumers of coal for electricity generation are those PSAs with large population and/or substantial industry.

The demand for coal by coke plants in the PSAs follows the demand for coke by the iron and steel industry. Overall consumption of coal by coke plants fell from 21 million tons in 1969 to slightly less than 17 million tons in 1976. Within the PSAs, the greatest consumption of metallurgical coal occurred in BEA 66 (Pittsburgh), where more than 13 million tons of metallurgical coal was consumed in 1976. Other major consuming areas of metallurgical coal are BEAs 62 (Cincinnati) and 52 (Huntington), whose combined total consumption in 1976 was only 21.0 percent of the PSAs' metallurgical coal consumption.

The consumption characteristics of Group I commodities and products may be divided into three broad categories: economic, institutional and technological.

The consumption of steam coal is a product of shifting relative prices of energy fuels, new technologies and environmental concerns. The demand for steam coal is a derived demand. As such, the economic characteristics of steam coal usage are determined by

the nature of the demand for electricity; the short-run substitution possibilities among fossil fuels; the long-run substitutability of alternative fuels for electricty generation; and possible alterations in the physical form of coal, such as gasification and liquefaction.

There are three technical elements which influence steam coal consumption. These are the content of ash in coal, the sulfur content, and the calorific, or heat value, of coal. To generate a given level of electricity, boilers are designed to use coal ranked at a given Btu content. A drastic difference between the Btu content specified by boiler design and that of the coal actually burned will result in a costly reduction of boiler efficiency. Excessive amounts of ash also reduce efficiency in a steam boiler.

Several institutional characteristics of coal use influence steam coal consumption. The most important at this time are Environmental Protection Agency (EPA) regulations regarding sulfur dioxide emissions which influence the demand for high sulfur coal. Other institutional factors include the ownership of reserves, the distinction between contract and spot markets, and coal conversion policies.

The demand for metallurgical coal is also a derived demand, dependent on the demand for coke. The levels of sulfur, ash, and volatile content determine whether a certain coal is acceptable to coke processing. Virtually all metallurgical coal is consumed in the production of coke. The demand for coke, in turn, is dependent on the demand for the products which use coke in production processes. More than 90 percent of all coke is utilized by the steel industry. Thus, the demand for steel is the overriding determinant of the amount of coke consumed.

Developments in the technology of steelmaking have resulted in a decrease in the amount of coke used per ton of pig iron produced. Other heat-producing inputs, such as fuel oil and natural gas, are used increasingly in blast furnaces to augment the heat produced by coke. The advent of the electric arc furnace, in which the generation of heat is provided solely by electricity, has eliminated the need for coke in a small but growing proportion of U.S. steel production.

The two important institutional characteristics of the metallurgical coal market are the ownership of reserves and federal environmental regulations. Steel company ownership of metallurgical coal reserves is extensive and has the effect of limiting

open trade in metallurgical coal. EPA regulations governing sulfur and particulate emissions have caused consumers of metallurgical coal to compete for the lower sulfur coals on the market.

Production of non-metallurgical coal experienced only moderate growth in the PSAs between 1969-76. Production increased from 419.2 million tons in 1969 to 437.0 million tons in 1976, an average annual rate of 0.6 percent. The PSAs' 1976 coal production represented almost 65 percent of national production. Underground production in the PSAs decreased by 2.2 percent yearly, while surface and auger production increased at a rate of 5.4 percent annually. The three BEAs which historically have been the predominant producers in the ORB remained so during the period, but their share of total PSA production decreased. BEAs 66 (Pittsburgh), 52 (Huntington) and 55 (Evansville) accounted for 63 percent of non-metallurgical coal production in 1976.

Production of metallurgical grade coal in the PSAs during the period 1969-75 decreased at a rate of 1.2 percent annually. Total production fell from nearly 75 million tons in 1969 to nearly 70 million tons in 1975. A locational shift in production occurred during this time period, with production decreasing dramatically in those BEAs where relatively high sulfur coal was mined. BEAs 66 (Pittsburgh) and 52 (Huntington) were the largest producers of metallurgical grade coal. Together, they accounted for 49.4 million tons or 70.8 percent of all PSA production in 1975. The only other large producer of metallurgical coal was BEA 51 (Bristol), which accounted for 16.5 percent of production in 1975.

The supply of coal is determined by such economic characteristics as the prices paid for coal, prices of coal substitutes, mining productivity, and capital and labor costs which influence the cost of mining. Among the factors determining mining cost and productivity are mine size and geology, specifically depth, thickness and uniformity of coal in underground mining, and slope and overburden in surface mining. Institutional factors, such as Federal laws and regulations, and the unionization of the work force, impact on coal production. Most of these institutional impacts are negative; that is, they tend to reduce production by increasing mining costs and coal prices.

Consumption of coal in the PSAs during the next 60 years is forecast to grow at a much slower rate than in the past. Between 1976 and 1990, consumption of Group I commodities is expected to grow at an annual rate of 1.8 percent; increasing from 194.6 million tons in 1976 to 216.8 million tons in 1980 to 268.9 million

tons in 1990. Consumption is expected to slow in the later years of the projection period, reaching a level of 606.6 million tons in 2040. The growth in consumption will occur largely due to consumption by electric utilities and other uses of non-metallurgical coal. Metallurgical coal consumption is expected to decline through the next 20 years and to increase after the year 2000.

Production of coal in the PSAs is projected to increase at a rate of 2.6 percent per annum between 1976 and 1990 and at 1.5 percent annually for the entire projection period 1976-2040. These accelerated production rates are due to the increased level of demand for coal and to the limited ability of western coal to make inroads into the market areas of the PSAs prior to 2000. Production within the PSAs will increase from 437 million tons in 1976 to 627 million tons in 1990 up to 1.1 billion tons in the year 2040. By 1990, the PSAs' share of U.S. coal production is expected to decline to 57 percent.

Over half of the coal shipped in the United States is moved by rail. Waterway movements of coal account for less than 20 percent of shipments. Other modes of transportation by which coal is moved include truck, Great Lakes carriers, tidewater movments, and tramways and private railroads.

Rail movements of Group I commodities in the PSAs totaled over 463 million tons in 1976. Outbound rail movements amounted to 261 million tons of this total. Local movements, amounting to 192 million tons, were generally flows from land-locked mining areas to transshipment facilities on the waterway for final shipment to PSA consumers. Particularly large rail movements of coal occurred in BEAs 52 (Huntington), 55 (Evansville), and 66 (Pittsburgh).

Waterway movements of Group I commodities were relatively important only in those BEAs where consumption takes place near the waterway. A total of 116.5 million tons of coal and coke were shipped on the ORS in 1976. Local movements, amounting to 101.1 million tons, were the most important Group I waterway flows. Most of the waterborne movements of coal tend to originate from or be destined for BEAs 66 (Pittsburgh), 65 (Clarksburg), 62 (Cincinnati), 52 (Huntington), and 51 (Bristol).

In moving coal, the choice of mode usually is determined by the length of the haul and the loading and unloading facilities at the points of production and consumption, as well as the relative cost of the possible modes. Some of the most important factors influencing the choice of rail as a mode to move coal are unit

train rates, the general disrepair of substantial amounts of track, and periodic shortages of hopper cars and other equipment. Barge is often chosen as a mode for transporting coal in a line-haul of 200 miles or more; at such distances barge proves to be the least expensive mode of transport. Truck transportation of coal, the most costly, and yet the most flexible of all the modes, is the most efficient for short-distance hauls.

In general, the factors affecting modal choices for coal transport are the physical structure and location of the transportation network in relation to production and consumption areas and relative transport cost.

The modal split of the PSAs is not expected to shift markedly in the future. Rail is expected to remain the dominant mode for shipping coal and coke; water is expected to be the second most important mode. Between 1976 and 2000, waterway flows are projected to increase 75 percent over 1976 levels, reaching 183.5 million tons in 1990 and 204.2 million tons in 2000. The growth rate of waterway coal shipments is expected to decrease slightly in the following decades as alternative sources of energy are developed, and as pipeline transmission of liquefied or gasified coal replaces some waterway transport. The projected waterway movements of coal in the ORS are 228 million tons and 254 million tons in 2020 and 2040, respectively.

During the projection period, inbound shipments of coal are expected to increase rapidly as western coal begins to move into the PSAs. However, most of this increase probably will not begin until the mid 1980s. Outbound waterborne movements of coal are expected to fluctuate while local movements are projected to increase steadily from 101 million tons in 1976, to 148.2 million tons in 1990, to 193.5 million tons in 2040.

B. Petroleum Fuels

Group II, petroleum fuels, consists of six major, relatively high-gravity petroleum liquids derived from crude oil refining. Gasoline, jet fuel, distillate fuel oil, and residual oil account for nearly all of Group II waterborne shipments. Also included in the group are kerosine and liquefied petroleum and other gases.

Motor gasoline and jet fuels are used almost exclusively in activities directly related to transportation, including highway, agricultural, aviation and marine uses.

Distillate fuel oil is a general classification of petroleum fuel consisting of fuel oils and diesel fuels. About one-half of distillate fuel oil is consumed by the residential-commercial sector for heating, nearly 40 percent by the transportation sector, and most of the rest by the industrial sector.

Consumption of petroleum fuel in the PSAs was estimated at 47.6 million tons in 1976, approximately 6.1 percent of national consumption. During the period 1969-76, consumption of petroleum fuels in the PSAs increased 30 percent compared to 26 percent for the Nation as a whole. Gasoline, distillate fuel oil and residual fuel oil accounted for 94 percent of total petroleum fuel consumption in the PSAs in 1976. Consumption was fairly equally distributed among 14 PSAs, with the exceptions of BEA 66 (Pittsburgh), which alone accounted for 25 percent, and BEAs 65 (Clarksburg), 68 (Cleveland), and 115 (Paducah), which together accounted for 3.5 percent.

Unlike the rapidly increasing consumption, production of petroleum fuels at refineries in the PSAs did not increase significantly in the past decade. Production remained nearly constant at around 14 million tons annually from 1969 to 1973 and then rose slightly to about 16 million tons by 1975 and 1976. National production rose steadily from 498 million tons in 1969 to 635 million tons in 1976, with only a short setback in 1974 after the Arab oil embargo. The BEAs producing the largest amounts of petroleum fuels were BEAs 52 (Huntington) and 55 (Evansville).

Demands for petroleum fuels are dependent on population, income, technology, and the prices of substitute fuels. In addition, the use of particular fuels is influenced by special factors, such as the effect of automobile ownership, size, and fuel efficiency on gasoline consumption. Future demand for petroleum fuels will also be affected by supplies of crude oil and the effectiveness of planned national energy conservation. In the PSAs, consumption of petroleum is projected to follow past trends and increase rapidly until 1990 and then decline in absolute amounts by 2000. The average annual growth rates are estimated to be 1.62 percent for 1976 to 1990 and (0.34) percent over the entire period 1976-2040. BEA 66 (Pittsburgh) will continue to be the major consuming area, while BEAs 68 (Cleveland), 65 (Clarksburg), and 115 (Paducah) will remain the smallest consumers.

Projections of production of petroleum fuels in each BEA are based on the same growth rates as projected consumption of crude oil in the BEAs as developed in the Crude Petroleum (Group III)

Report. Production is projected to grow at a rate of 3.17 percent per year from 1976 to 1990 and to decline thereafter at accelerating rates as a result of limited domestic crude oil and high import prices. Projected production in the PSAs is 10.2 million tons in 2040, a decline of 0.69 percent per year for 1976-2040.

The most common mode of transportation for petroleum fuels in the United States is pipeline because of its timeliness and low cost. Pipeline is also the predominant mode in the ORS, but waterborne shipments are relatively more common there than elsewhere in the Nation because of the availability of convenient river systems. Generally water transport is used in those areas which do not have product pipeline connections.

A new pipeline connecting Terre Haute and Louisville was completed in 1977, reducing water transport between those areas and creating a cost advantage in the ORB for fuel produced in Illinois over those imported from the Gulf Coast. However, because of this large investment required in constructing pipeline and the anticipated future decline in production and consumption, no further additions to pipeline are forecast for the ORB. Therefore, except for the near term shifts associated with 1977 pipeline, no changes in the modal split are projected through 2040.

Although net shipments of all modes of transportation are projected to increase slightly, by 0.72 percent per year, from 1976 to 1990, net waterborne shipments are expected to decrease by 5.65 percent per year, principally because of reduced inbound water traffic. Local waterborne shipments are projected to nearly double in this period. Gross waterborne shipments are projected to increase from 20.9 million tons in 1976 to 28.3 million tons in 2000 and then decline to 15.8 million tons by 2040.

C. Crude Petroleum

Group III is composed of a single commodity, crude petroleum, which is not significant in waterborne transport in the ORS, now or in the future. Light crude produces a larger proportion of valuable fuels than heavy crude, but this distinction does not affect transport considerations. Likewise, the analysis does not distinguish between high sulfur and low sulfur crudes even though the high sulfur crude requires special pollution control equipment, because the ORB has an excess of this capacity.

Crude petroleum is consumed by oil refineries. In the PSAs, crude oil is consumed in BEAs 55 (Evansville), 64 (Columbus), and

66 (Pittsburgh). Total consumption in the PSAs increased from 1.4 million tons in 1969 to 1.9 million tons in 1976. Total U.S. consumption increased at approximately the same rate from 578 million tons to 746 million tons in the same period, such that the ORB's share of national consumption was less than one-half of one percent throughout.

Demand for crude oil is derived from demand for petroleum products such as motor gasoline, jet fuels, and heating oils. Demand for these products is dependent on factors such as income, population, prices of alternative energy forms, the availability of substitutable resources, and technology. In the long run, the depletion of worldwide oil reserves and the resulting effect on fuel prices and economic growth will have a strong negative impact on consumption of crude oil.

Production of crude oil in the PSAs is limited by available reserves. During the period 1969-76, production declined from a high of 4.5 million tons, in 1969, to a low of 2.2 million tons in 1976. BEA 55 (Evansville) accounted for 97 percent of total PSA production, with the remainder in BEAs 64 (Columbus) and 66 (Pittsburgh). Oil reserves in the PSAs are expected to decline in the future, although higher prices for crude oil should encourage reopening of old wells, more exploration, and the development of new technologies to improve drilling efficiency.

In the PSAs, crude petroleum consumption by refineries is projected to increase rapidly in the near term from 1.9 million tons in 1976 to more than 2.6 million tons in 1980 as a result of increasing demand for and prices of petroleum fuels and products. In subsequent decades, however, consumption of crude petroleum is expected to decline, falling to 0.8 million tons by 2040, as the negative effects of high oil prices on petroleum fuels, the lower supply of crude oil in the PSAs, and the availability of new energy sources become important factors.

Gross waterborne shipments of crude petroleum in the ORS declined from 6.6 million tons in 1969 and nearly 8 million tons in 1971 to only 0.7 million tons in 1976. The decline was partly due to lower crude oil production in the PSAs but primarily because of the development of a more extensive pipeline system for local deliveries. Pipelines have virtually replaced barge transport of crude oil for local shipments within the ORB because of their convenience, reliability and cost savings. In 1976, waterborne shipments, all of which were inbound, totaled 664.5 thousand tons, while net pipeline (including truck) shipments were 938.1 thousand tons.

Because of the high cost of pipeline construction, and declining petroleum resources in the PSAs, it is expected that no additional pipelines will be built. In projecting waterborne shipments, it was assumed that there will be no change in the present modal split. Net waterborne shipments (all inbound) in the ORS will increase by 1.57 percent per year from 1976 to 1990 and decrease by an average 1.02 percent per year for the period 1976 to 2040.

D. Aggregates

Group IV, aggregates, consists of construction and industrial materials, including sand and gravel, building stone, and flux. In 1969-76, aggregates accounted for 13.2 percent of ORS waterborne traffic. Most of these shipments were local. Nearly all waterborne shipments of aggregates were in one of two categories of products, sand, gravel, and crushed rock or limestone flux. Marine shells and building stone, although classified as aggregates, are not used or shipped in sufficient amounts to warrant being included in projections of waterborne traffic.

The major distinction among uses of sand, gravel, and crushed rock (including limestone) is between construction aggregate and crushed rock for industrial purposes.

Construction Aggregate. In 1976, 96.8 percent of U.S. sand and gravel production and 75.2 percent of crushed rock production were used in construction. The largest construction use of sand and gravel in 1976 was for concrete, which consumed about one-third of production. Other important construction uses of sand and gravel were in roadbase and coverings, fill, asphalt, and concrete blocks. Construction use of crushed rock in 1976 was largely for roadbase, roadstone, and similar uses. More than 28 percent was mixed with cement, bituminous, or asphalt for concrete or pavement material. In construction use, considerable substitution among similar aggregate materials is possible.

Industrial Aggregate. Virtually all aggregate-type material used in industry is crushed rock. The most important industrial use is cement manufacture. Other industry users include lime, pig iron, and steel. Consumption for industrial use is concentrated geographically at specific industrial locations, and large shipments by barge or rail are common. For industrial uses, chemical and physical properties as well as dimension specifications of aggregate materials are important.

Consumption and production of aggregates are closely related because most demands are met from nearby sources, and it is usually not necessary for producers to hold inventories. In the period 1969 to 1976, consumption in the PSAs varied between a low of 127 million tons in 1972 and a high of 153 million tons in 1973. Consumption was 132 million tons in 1976, about 7 percent of national consumption of sand and gravel and crushed rock.

Demand for construction aggregates is a function of construction demand, principally public works (including highway construction and maintenance) and commercial construction of both residential and industrial types. Both commercial and public demand for aggregates are linked to economic growth and population trends. Size and density are generally the only necessary specifications for construction aggregate, and several kinds, such as crushed rock and gravel, are near perfect substitutes.

Construction accounted for more than 89 percent of aggregate use in the PSAs in 1976. Consumption of construction aggregates was highest in BEAs 66 (Pittsburgh), 49 (Nashville), 62 (Cincinnati), and 54 (Louisville). The bulk of industrial aggregates was used in cement manufacture, but use in the manufacture of pig iron was also large, particularly in Pittsburgh.

Demand for aggregates in the PSAs is projected to increase from an average of 132.7 million tons in 1974-76 to 229.9 million tons in 2040. The rate of increase is projected at 1.2 percent per year from 1974 to 2000 and at 0.6 percent per year from 2000 to 2040. For construction aggregates consumption, projections are derived from projections of per capita demand and population projections by BEA. Industrial aggregates demand is based on projections of use by the cement, lime, pig iron, and steel industries. No use of aggregates in the construction of nuclear power plants was included in the projections because of the uncertainty of national policy on nuclear power development. Pittsburgh, Cincinnati, Louisville, and Nashville will continue to be the primary consumers of aggregates.

Since most aggregates production is determined by local demand, production projections were based on consumption projections, adjusted for net shipments. Shipment patterns reflect certain constraints of availability and institutional factors. For instance, waterway deposits suitable for dredging are being exhausted in many areas, particularly the upper Ohio and Allegheny Rivers. Also, environmental regulations, both existing and potential, are

further discouraging expansion of dredging operations. Substitution of crushed rock for gravel and artificial sand (made from limestone) for sand is also affecting production of these aggregates in some locations.

Production of aggregates in the PSAs is expected to increase from an average of 128.0 million tons in 1974-76 to 172.2 million tons in 2000 and 222.5 million tons in 2040. The annual rates of increase projected are the same as those for consumption. The major producing PSAs will continue to be BEAs 66 (Pittsburgh), 49 (Nashville), 54 (Louisville), and 62 (Cincinnati), although it is expected that Pittsburgh will not maintain its leading position.

Because of the availability of water transport near production and consumption centers, a much greater share of aggregates shipments is waterborne in the ORB than is true of the Nation as a whole. In 1976, more than 16 percent of the PSAs' production was shipped by water, compared to 6.5 percent of national production. Choice of transport mode is usually determined by cost, availability and flexibility of various modes, and type of extraction. Truck shipments dominate local transport, since most consumption is not located directly along water or rail systems and since many uses require relatively small lots. However, truck transport is more costly than rail and water for large shipments, so the latter modes are likely to be used when possible. A large part of aggregates production in the PSAs is produced by dredging, and this material invariably moves by barge.

Total waterborne receipts of aggregates of the PSAs were projected as a slowly declining percentage of projected consumption. Gross waterborne shipments are projected to rise from 25 million tons in 1976 to 31 million tons in 2000 and 40 million tons in 2040. Local movements will continue to account for the bulk of waterborne shipments. Inbound movements will remain relatively small, since sand and gravel are abundant within the PSAs. Outbound movements are projected to increase somewhat faster, rising from 5.0 percent of the total in 1976 to 8.8 percent in 2040.

E. Grains

Commodity Group V consists of grains. In 1976, the Ohio River System (ORS) accounted for about 11 percent of the corn, 10 percent of the soybeans, and 12 percent of the wheat shipped on domestic waterways. Although grains represented only 3 percent of total waterborne commerce in the ORS in 1976, they were one of the fastest growing waterborne commodity movements, flowing to and/or

from almost every major port equivalent (PE) in the inland waterway system. Grains also provided one of the higher value and longer haul movements in the System.

The total inbound, outbound, and local grain traffic in the ORS was recorded at 3.3 million tons in 1969, increasing to 5.6 million in 1976. Two distinct trends can be noted in regard to ORS waterborne grain movements. Outbound grain increased at an average annual rate of 30.7 percent, increasing the relative share of grains in total ORS outbound traffic from 3.9 percent in 1969 to 15.0 percent in 1976. The inverse was the case in regard to inbound movements, which decreased from 2.5 million tons in 1969 to 1.4 million in 1976, an average annual decrease of 8.0 percent. Local grain movements within the ORS remained relatively small and unchanged.

The individual products included in Group V are:

Waterborne Commerce Statistics Code (WCSC)	Product
0102	Barley and rye
0103	Corn
0104	Oats
0105	Rice
0106	Sorghum
0107	Wheat
0111	Soybeans

The most important grains, in terms of total past and future ORS waterborne movements, are corn, wheat, and soybeans. In 1976, these grains accounted for 52.6, 26.1, and 20.0 percent of ORS waterborne grain traffic, respectively. These three commodities accounted for between 94 and 99 percent of the waterborne movements of grains in the ORS between 1969-76. The other four commodities had relatively small waterborne movements in the 1969-76 period -- between 1 and 6 percent of total waterborne grain traffic.

Corn is primarily a feed grain that is converted into pork, beef, poultry and dairy products. Over 60 percent of all corn consumed in the United States is fed to livestock. An additional 30 percent moves into the export market, primarily to Japan and to

the European Economic Community. Corn food uses, including starch, syrup, sugar, oil and alcoholic beverages and nonfood uses, such as soaps, paints and varnishes, polishes and inks, and paper, account for the remaining 10 percent.

Wheat, primarily a food grain, is converted into cereals or into flour for use by the baking industry in bread and other bakery products. Approximately 60 percent of the wheat produced in the United States is exported; 30 percent is used in food, primarily flour; 5 percent is fed directly to livestock; and the remaining 5 percent is used for seed.

Approximately 60 percent of domestic soybean production is crushed, yielding soybean meal and oil as products. Soybean meal is a high protein animal feed, presently accounting for over half the total protein feed supply. Soybean oil is the principal oil source in the manufacturing of margarines, shortenings, and cooking and salad oils. Nonfood uses of soybean oil include use as a drying oil for linoleum, in paints and varnishes, in lubricants, vinyl, and alkyd resins, and as a mix with linseed oil. Of the 40 percent of soybeans produced and not crushed, almost all are exported and little is used for seed or fed to livestock as raw beans.

Consumption of corn, wheat, and soybeans in the PSAs during 1969-76 fluctuated between 22.0 million tons and 24.7 million tons. However, in general, consumption decreased during the period. In the ORS hinterland, consumption was concentrated in 12 of the 19 PSAs, mostly in the southeastern area of the hinterland. BEAs 54 (Louisville), 44 (Atlanta), 60 (Indianapolis), 62 (Cincinnati), and 63 (Dayton), major producing PSAs, accounted for a large percentage of ORS hinterland grain consumption. These BEAs were and are expected to be significant producers of meat, poultry, and food and dairy products for northeastern and southeastern U.S. markets. Corn was the predominant feed grain, followed by soybeans and wheat.

Livestock is the major consumer of grain in the United States and in the area served by the ORS. Between 1969-76, on the average, livestock accounted for 75 percent of the corn, wheat, and soybeans consumed in the PSAs. Commercial processing accounted for between 22 and 25 percent of grain consumption in the ORS hinterland during 1969-76. Consumption of grain for seed is a minor end-use and accounted for less than 1 percent of total grain consumption in 1970 to more than 1.5 percent in 1976.

Much of the grain produced in the PSAs was consumed by the export market, but the majority was consumed domestically in the Northeast and in areas in the Southeast exterior to the ORS hinterland.

The price of grain is determined by the interaction of derived demand and grain supply functions. As incomes, population, expected prices, and prices of competing and complementary goods change in the United States and in the world, the demand for meat, oil products, flour, and cereals changes. Grain is sold in an international market; therefore, the price and the movement of grain depends, in part, on world demand.

Grain production in the ORS hinterland is characterized by intensive utilization of cropland, increasing acres harvested of all acres planted, and higher yields per acre.

ORS hinterland production of corn, wheat, and soybeans, the most important waterborne grains, increased steadily between 1969-76. Almost 16 million tons of grain were produced in the ORS hinterland in 1969, increasing to 25.6 million tons in 1976. The increase represents an annual growth of 7 percent. In the ORS hinterland as a whole, production was concentrated in five PSAs. BEAs 55 (Evansville), 60 (Indianapolis), 62 (Cincinnati), 63 (Dayton), and 64 (Columbus) represented between 65 to 70 percent of total hinterland grain production during 1969-76. Although these PSAs exhibited strong growth in production between 1969-76, the greatest increase occurred in the southeastern PSAs. Between 1969 and 1976, grain production increased in each of the 19 PSAs in the ORS hinterland without exception.

Production of the three major crops in the ORS hinterland increased at a faster rate than U.S. production during the 1969-76 period. In 1976, the PSAs produced 10.7 percent of the corn grown for grain in the United States, 3.2 percent of all wheat, and 12.2 percent of U.S. soybeans for beans.

The factors that will determine future production of grains are economic, institutional and technological in nature. World economic conditions have fostered the growth in U.S. output of soybeans, corn and wheat. Because of economic development, the world is demanding more meat and protein products. Increasing incomes and population growth have stimulated international demand for cereals and flours. Primarily through price support, U.S. agricultural programs have been an important stimulant for the

production of feed grains and wheat. Agricultural extension programs and research efforts have aided the increase in U.S. agricultural productivity. The introduction of hybrid seeds, fertilizers, herbicides, insecticides, and new machinery have substantially increased crop yields and so production. Weather, insect infestation, and blight can have adverse, although generally short-term, effects on grain production.

The projections for grain consumption in the PSAs suggest gradual but steady increases in total grain consumption between 1976 and 2000, 0.54 percent annually, and between 2000 and 2040, 0.19 percent annually. Total consumption of grain in the PSAs is expected to reach 22.4 million tons in 1980 and 23.3 million tons in 1990. Beyond 2000, grain consumption is expected to increase at a decreasing rate, reaching a level of 27.1 million tons in 2040. Corn will be the predominant grain consumed, and livestock will remain the major consumer of all grain.

A notable decrease in grain production is expected to occur between 1976 and 1980, when production will drop more than 20 percent from 25.6 million tons to 19.9 million tons. This decline in production is a function of expected decreases in corn acreage, which yields almost three times as much grain per harvested acre as soybeans and wheat. To some extent, increases in soybean production offset the corn decline. Between 1976 and 2000, grain production in the PSAs is expected to increase at an annual rate of 1.01 percent, reaching a level of 25.2 million tons in 1990 and 32.5 million tons in 2000. BEAs 49 (Nashville), 54 (Louisville), 55 (Evansville), 60 (Indianapolis), 62 (Cincinnati), 63 (Dayton), 64 (Columbus), and 115 (Paducah) are expected to remain the prime ORS hinterland production areas.

The production, marketing, and utilization of grain relies on an integrated and complex grain-marketing system. The mode by which grain moves to various destinations depends on the demand, the relative cost and availability of transportation facilities, and the distance to be covered. More specifically, modal choice can be determined by such factors as topography and severe weather; institutional limitations established by governmental practices, such as railroad rate zones and territories; changes and developments in the total transportation network; the availability, capacity and capability of certain facilities, such as a barge loading and unloading facility; and the seasonality of grain movements.

The ORS hinterland has been and is expected to remain (with the exception of 1980) a net exporter of grain. BEAs 55 (Evansville), 60 (Indianapolis), 62 (Cincinnati), 63 (Dayton), and 64

(Columbus) are expected to generate the greatest volume of outbound shipments by both water and rail, with rail continuing to be the most important mode of transport.

Between 1976 and 1980, waterway flows are expected to decrease, dropping from a 1976 level of 5.6 million tons to 4.2 million tons. This will result from the decrease in corn production discussed earlier. After 1980, waterway movements are expected to increase steadily to 6.0 million tons by 2000 and to 8.6 million tons by 2040. Over the entire period 1976-2040, inbound waterborne movements are expected to decrease at an average annual rate of 0.52 percent. However, outbound movements are expected to increase an average 0.95 percent per annum, and local movements are expected to increase at a rate slightly faster than outbound to remain small relative to total waterborne grain movements in the ORS.

F. Chemicals

Group VI consists of chemicals and chemical fertilizers, which accounted for significant volumes of waterborne traffic in the ORS in 1969-76, particularly for inbound shipments. Among the chemicals having sizeable volume of water traffic were the following: (1) industrial chemicals including sodium hydroxide, crude products from coal tar, petroleum and natural gas, alcohols, benzene and toluene, sulfuric acid, basic chemicals, and miscellaneous chemical products; and (2) nitrogenous, potassic, and phosphatic chemical fertilizers and other fertilizers and fertilizer materials. A number of other chemical products such as plastic materials, paints, and insecticides, were not included in the analysis because they do not enter into waterborne commerce in any significant amounts.

Because of the wide variety of industrial chemicals and continuing development and change in the industry, the industrial chemicals were analyzed as four chemical groups: sodium hydroxide; sulfuric acid; benzene and toluene; and other industrial chemicals.

Sodium Hydroxide. Sodium hydroxide (or caustic soda) ranked sixth of the top 50 chemicals in terms of national production in 1976 and was the largest single chemical in volume of waterborne traffic. However, most of the waterway shipments are at points near production centers along the Mississippi River and Gulf Coast, and volume on the ORS is considerably lower. Sodium hydroxide has many end uses, including use as a scouring agent and in the manufacture of soaps, soluble oils, chemicals and textiles.

Sulfuric Acid. Sulfuric acid is the top ranked chemical in terms of national production, but its shipment by water is limited because it is highly corrosive and expensive to ship, and it is normally produced as a captive input of a vertically integrated firm.

Benzene and Toluene. Benzene and toluene ranked 13th and 17th, respectively, in production of major chemicals in 1976, exclusive of their production for gasoline. Most of toluene production is used for benzene production, and a large portion of benzene production as well is used in the manufacture of other chemicals. In 1976, over one-half of benzene and toluene production was shipped by water, primarily near production centers along the Mississippi River and Gulf Coast.

Other Industrial Chemicals. The category "other industrial chemicals" includes thousands of chemical products such as oxygen and nitrogen, inorganic acids such as hydrochloric and nitric acids, and petrochemicals such as ethylene and propylene. Forty-one of the 50 major chemicals (in terms of U.S. production) are included. Of their total production, about 19 percent were shipped by water in 1976.

Agricultural chemicals accounted for 10.7 percent of Group VI waterborne commerce in 1976. Nearly all of this consisted of nitrogenous fertilizers and the category, fertilizer materials, nec.

Nitrogenous Fertilizer Materials. Nitrogenous fertilizers include urea, ammonium nitrate, ammonium sulfate and other nitrogenous materials, most of which are derivatives of ammonia. Over three million tons were shipped on domestic waterways in 1976, in large measure originating at production centers on the lower Mississippi River. Most waterway shipments consisted of urea; ammonium nitrate is an explosive material and restricted in water transport.

Potassic Chemical Fertilizers. Potassic chemicals can move by any mode of transportation. Potash is mined in Canada and the western United States, however, so production location does not lend itself to significant use of water transport. In 1976, domestic use of waterborne commerce totaled 376.8 thousand tons, primarily in coastal shipments.

Phosphatic Chemical Fertilizers. Phosphatic fertilizers are based on phosphate rock which is mined in the southeastern United

States, primarily Florida. In 1976, domestic waterborne commerce of phosphatic fertilizers totaled 452.1 thousand tons.

Fertilizers and Fertilizer Materials, Nec. The final category of agricultural fertilizers included in the analysis consists of diammonium phosphate (DAP), ammonium phosphates, other mixed chemical fertilizers, and natural animal or vegetable fertilizers. The convenience of production sites to waterways allows significant use of water transport for these materials. Their waterway shipment totalled 2.77 million tons in 1976.

Consumption of industrial and agricultural chemicals in the PSAs totaled 15.3 million tons in 1976, having risen an average of 8.4 percent per year from 1969 to 1976. Industrial chemical use accounted for 88 percent of the total. The major use of industrial chemicals is as inputs in the manufacture of other goods, primarily other chemicals. Demand for "bulk chemicals" which are used in the production of specialty chemicals and in other industries depends upon production in these industries, demand for the end use products, and conditions in the general economy. Over the period 1969 to 1976, consumption of industrial chemicals in the PSAs grew at an average rate of 8.8 percent, reflecting industrial growth in the area. Growth in the chemical industry has been impeded in recent years by inflationary pressures (particularly due to the industry's high energy use), the costs and restrictions of government regulations, and reduced expenditures for new product development, which has been a major source of growth in the past.

Agricultural chemicals consist of both intermediate chemicals used in the production of fertilizers and the end product fertilizer themselves. Consumption of agricultural chemicals has expanded in the last decade to about 50 million tons annually, in response to agricultural export demand and increased use of crop fertilizers, particularly nitrogen for corn. Demand for chemical fertilizers depends on the relationships between fertilizer costs and crop yields and the prices for various agricultural products. Short-term changes in these relationships are frequent, complex, and significant. Technological changes in the storage and handling, transport, and application of chemical fertilizers also affect consumption. Bulk blending plants, which mix but do not chemically alter fertilizer ingredients gathered from various production points, are the most common type of units for manufacturing and distributing fertilizer in the ORB, as they are nationally. There are 190 bulk plants in the PSAs, as well as 11 granulation and 89 liquid and suspension mix plants. Consumption

of agricultural chemicals in the PSAs increased at 6.6 percent per year from 1969 to 1976.

The geographical distribution of production of the U.S. chemical industry shifted in the late sixties from a scattered, market-oriented pattern to greater concentration near input production areas of the Southeast, Southern Plain, and Delta states. Production in the ORB increased only slightly from 7.9 million tons in 1969 to 10.0 million tons in 1976. The major producing PSA was BEA 52 (Huntington) which experienced a decline in production during the period; substantial growth occurred in some smaller producing PSAs, principally BEAs 50 (Knoxville) and 66 (Pittsburgh).

Consumption of chemicals in the PSAs is projected to increase at 3.2 percent annually from 1974-76 to 2000 and at 2.1 percent from 2000 to 2040. Most of this increase will be in industrial chemical use. Agricultural chemical use will increase relatively little, primarily because of an expected shift away from corn production to soybeans.

Production of industrial and agricultural chemicals in the PSA is projected to increase at 3.7 percent annually from 1974-76 to 2000 and at 2.2 percent annually from 2000 to 2040. The most rapid increase is projected for BEA 47 (Huntsville), which will make that area the major producing PSA by the year 2020.

At the national level, water transport is a major, although not the leading, mode for industrial and agricultural chemicals. Within the PSAs waterborne shipments were significant, estimated at 6.4 million tons inbound, 0.9 million tons outbound, and 4.1 million tons locally in 1976. Gross movements of chemicals by water and by rail were approximately equal, but inbound and outbound rail shipments were nearly balanced, unlike water shipments. Relatively more industrial chemicals moved by water, and relatively more agricultural chemicals moved by rail. Projections of modal split were based largely on existing relationships and projections of consumption and production. Gross waterborne shipments are projected to increase from 11.4 million tons in 1976 to 22.4 million tons in 2000 at 2.7 percent per year. From 2000 to 2040 the average annual increase is projected to be 2.3 percent.

G. Ores and Minerals

Group VII, ores and minerals, consists of nonferrous ores and metallic and nonmetallic minerals, excluding fuels. Five of the

ten commodities in this group accounted for 95 percent of ore and mineral movements in the ORS. These were: (1) bauxite and other aluminum ores and concentrates; (2) manganese ores and concentrates; (3) other nonferrous metal ores and concentrates, including zinc; (4) salt; and (5) liquid sulfur. The other five commodities (copper, clay, including ceramic and refractory materials, dry sulfur, crude gypsum and plasters, and other nonmetallic minerals) are not expected to be transported by water in any significant quantities in the future and were not included in the projections.

With the exception of zinc, none of the relevant ore and mineral group commodities is produced in the ORB, and waterway shipments are therefore primarily inbound. Consumption of most Group VII commodities in the ORB as elsewhere, is determined largely by the demand for the final goods for which they are production inputs. Consumption of the ores and minerals group in the PSAs averaged over 5.9 million tons per year during 1969-76. Except for 1976, when over 6.7 million tons of ores and minerals were used, total consumption remained fairly stable, with fluctuations in individual commodities tending to the offsetting. BEA 66 (Pittsburgh) was consistently the largest consuming PSA of ores and minerals, followed by BEAs 55 (Evansville), 50 (Knoxville), and 47 (Huntsville).

Manganese Ore and Concentrates. The principal use of manganese is for the production of iron and steel. As an alloy it imparts strength, toughness, hardness, and solidity to steel. It is also used in the production of dry-cell batteries, as a fluxing agent in smelting, and as a trace element in fertilizer and animal feeds. The consumption of manganese ore and concentrates in the PSAs fluctuated widely during the period 1969-76, reflecting the fluctuations in steel production. In 1976, consumption in the PSAs was 1.0 million tons; the highest year for the period was 1974 when consumption was 1.5 million tons. Since manganese is normally converted to ferromanganese or silicomanganese prior to its use in steel production, inbound shipments of manganese terminate at BEAs containing ferroalloy plants. These BEAs are 48 (Chattanooga), 64 (Columbus), 66 (Pittsburgh), and 115 (Paducah).

Liquid Sulfur. The principal consumer of sulfur is the chem--cal industry which uses sulfur as a chemical reagent with other chemicals, often processing it first into an intermediate chemical such as sulfuric acid, desulfide, or sulfur dioxide. Sulfuric acid, which accounts for 90 percent of sulfur use, is used mainly in the production of fertilizers, and to a lesser extent in

plastic, paper, paints and nonferrous metal production. Consumption of sulfur in the PSAs increased steadily from 469 thousand tons in 1969 to 585 thousand tons in 1976, due to growth in the chemical industry in the region and increased usage of sulfuric acid. BEA 52 (Huntington) was the largest consuming area, using 98 thousand tons of sulfur in 1976.

Salt. The salt that is transported into the ORB via the waterway consists of rock salt for use in deicing roads and highways in metropolitan areas. Nationally, the major use of salt is as an intermediate product in the chemical industry rather than as a deicer. Consumption of rock salt fluctuates from year to year since the primary determinant of its usage is the severity of winter weather. In recent years, slower growth in highway construction and concern over environmental impacts have limited use of salt for deicing. Consumption of rock salt in the PSAs in 1976 was 1.2 million tons, with the largest users being BEAs 66 (Pittsburgh), 62 (Cincinnati), and 64 (Columbus).

Zinc Ore and Concentrates. The principal use of zinc ore and concentrates is in the production of zinc metal, for ultimate use mainly in the construction, transportation, electrical and machinery industries. Zinc metal was produced at two locations in the ORB during 1969-76, BEAs 66 (Pittsburgh) and 65 (Clarksburg), which accounted for all consumption of zinc ore in the region. In 1976, consumption was estimated at 464 thousand tons.

Aluminum Ore and Concentrates. Nearly 90 percent of aluminum ore and concentrate consumed domestically is used in the production of aluminum metal, primarily for the construction and transportation industries. Aluminum is desirable as a light, non-corrosive, non-magnetic, and malleable metal. It is also relatively low-cost compared to other metal substitutes. Consumption of aluminum ore in the PSAs increased from 2.2 million tons in 1969 to 3.4 million tons in 1976. The principal user was BEA 55 (Evansville), followed by BEAs 47 (Huntsville), 50 (Knoxville), and 66 (Pittsburgh).

Zinc is the only one of the minerals studied which is produced in the ORB. Other Group VII commodities, such as clay and gypsum, are mined extensively in the ORB, but they were not included in estimates of production because they are not, and are not expected to be, transported by water. Zinc reserves in Tennessee (with Virginia) are estimated at approximately 8.0 million tons, about one-fourth of total United States reserves.

Of the remaining waterborne ore and mineral commodities, two are produced elsewhere in the United States and two are mainly imported. United States reserves of sulfur are estimated at 230 million tons. Much of these are located in the Gulf Coast sections of Louisiana and Texas. Salt, which is abundant worldwide, also comes to the ORB from along the coastline of Louisiana and Texas. Alumina ore and bauxite are primarily imported as is manganese, since the United States is lacking in these resources. Baton Rouge is the most important SPA. It ships both its own salt and sulfur and imported manganese ore.

Consumption of ores and minerals in the PSAs is projected to increase at an average annual rate of 4.4 percent from 1976 to 2000 and at a rate of 2.2 percent from 2000 to 2040. Most of the growth will be due to increased demand anticipated for alumina because of the trend toward lighter materials in automobiles, increased use of aluminum in housing and construction, and aluminum's relative cost advantage. Projections of consumption growth for the other commodities are somewhat lower, reflecting demand in industrial uses, particularly steel and chemicals, which is described in other reports.

Production in the PSAs, which was projected only for zinc, is expected to grow at 3.3 percent annually from 1976 to 2000 and at 2.6 percent from 2000 to 2040. This is the same rate as that projected for national zinc production.

Many of the commodities of Group VII originate in the Gulf Coast area, convenient to the Mississippi River System, either as foreign imports or as production from nearby mineral deposits. It is often most convenient and cost-effective to ship to inland consuming areas by barge, especially when the destinations are also located near the waterway. Most of the ORS ferroalloy plants are located near the waterway and can therefore receive imported manganese by barge. The chemical plants which use sulfur are likewise situated adjacent to the waterway. Rock salt, mined in the Gulf Coast area, also usually travels by barge to the large metropolitan areas in the ORS. Significant quantities of ore and minerals are moved by rail and truck in the PSAs, but these consist primarily of local movements of clay and gypsum (along with some receipts of alumina and manganese) which did not enter into waterway movement projections.

Projections of modal shares and waterborne shipments and receipts were based on 1976 transportation patterns. Waterborne

receipts by PSA were assumed to increase at the same rate as consumption, and waterborne shipments were assumed to increase at the same rate as production. Inbound waterborne shipments are projected to grow to 10.5 million tons in 2000 and to 25.1 million tons in 2040. Outbound and local shipments will remain only a small part of total waterborne shipments at 0.8 million tons and 0.5 million tons, respectively, in 2000 and 2.2 million tons and 1.1 million tons, respectively, in 2040.

H. Iron Ore, Steel and Iron

Group VIII, iron ore, steel and iron, consists of ferrous-bearing materials and products associated with the production and shipment of rolled steel mill products and of iron and steel castings. Commodities in this Group were divided into two categories for purposes of analysis: (1) raw and secondary materials which are inputs into the iron and steelmaking process, including iron ore and concentrates, pig iron, ferroalloys, and iron and steel scrap; and (2) iron and steel products, including intermediate shapes and forms, and rolled and milled steel products.

Within the PSAs, consumption/production of iron ore, steel and iron is determined primarily by the steelmaking capacity of the area. In 1976 this capacity was estimated at 49.6 million tons annually. Demand for these products is also derived from the demand for finished steel products. Nationally, the largest users of steel are the automotive and construction industries, followed by machinery, other transportation containers, and oil and gas. In addition, demand for certain types of raw materials in Group VIII depends on the type of steelmaking process being used in the area. In particular, the proportion of pig iron to scrap needed varies according to the type of furnace used, with relatively more pig iron required for the basic oxygen type which predominates in the ORB region.

The Ohio River Basin contains several of the major steel-producing districts in the United States, accounting for approximately 30 percent of national steel production in 1976. The primary producing areas in the ORB are Pittsburgh, Youngstown, Cincinnati, and Huntington. The process used predominantly in these areas is the basic oxygen furnace, but a large number of older, less efficient, open hearth furnaces remain in operation.

Iron Ore. Nearly all iron ore consumed both within the ORB and nationally is for use in making pig iron, which in turn is used for making steel. As a major steel producer, the ORB area is a

major iron ore consumer. In 1976, consumption of iron ore in the PSAs was estimated at 35.5 million tons, 28 percent of national consumption. As there are virtually no known reserves of iron ore within the PSAs, iron ore used in the area is shipped into the region, primarily from the Great Lakes area and foreign sources.

Pig Iron. Most of the steel plants in the PSAs are fully integrated, producing their own pig iron from iron ore in blast furnaces. Pig iron consumption in the PSAs was estimated at 23.4 million tons in 1976, based on production of raw steel by type of furnace and on foundry use. Since most of this production is for the plants' own use, only a relatively small amount, produced in excess of the plants' needs, enters trade as shipments of merchant pig iron to foundries.

Iron and Steel Scrap. Iron and steel scrap constitutes the other major raw material in steel production which can be substituted for pig iron in varying amounts, depending largely upon the type of furnace used. Electric and open hearth furnaces allow up to 100 percent use of scrap, while the basic oxygen furnaces can presently handle only 30 percent scrap, without first transforming the scrap into hot metal. In 1976, the PSAs consumed approximately 21.3 million tons of iron and steel scrap. Home scrap (by-products, waste and discards of iron and steelmaking) and purchased scrap (manufacturing waste and discarded final steel goods, such as automobiles) are produced in abundance in the ORB region. In 1969, approximately 18.2 million tons were generated from the PSAs.

Ferroalloys. Ferroalloys are added to steel to provide various specific qualities. The most commonly used ferroalloy, ferromanganese, is added to steel to counteract the harmful effect of sulfur and to increase the hardness and strength of the steel. The PSAs consumed approximately 577 thousand tons of ferroalloys in 1976. The area served by the ORS is the largest producing region of ferroalloys in the United States. In 1976, ferroalloy production in the PSAs totaled 1.6 million tons.

Production of steel in the PSAs has generally increased and decreased from year to year along with the United States total, reflecting changes in the demand for finished steel goods. In recent years, however, the PSAs' relative share of production has been declining, as new steel plants have located in the Midwest and West in order to be closer to major steel markets, such as Chicago and Detroit. This westward shift of production capacity is expected to continue and is a major factor in projecting Group VIII

consumption. Overall, some positive growth is projected for the ORB, but it is only one-half of the national rate. Within the ORB a similar relative shift of production away from older plants at Pittsburgh to newer, smaller areas is expected. A decline in production at Youngstown is projected through 1990 to reflect a plant closing.

The projections assume that steel plants currently operating in the ORB will be maintained and upgraded, although no new integrated or semi-integrated steel mills are anticipated in the forecast period. A major factor in the upgrading will be the replacement of existing open hearth furnaces with basic oxygen or electric arc furnaces, which will occur more rapidly in the ORB than in the Nation as a whole since there are more, older open hearth furances there in need of replacement.

Iron ore, steel and iron shipments accounted for 2.5 percent of all waterborne commerce on the Ohio River System in 1976. Inbound movements were 2.0 million tons, of which 36 percent was iron ore and 23 percent was ferroalloys. Outbound movements totaled 1.5 million tons, of which 40 percent was plates and sheets and 33 percent was pipe and tube. Shipments of plates and sheets were primarily to storage and distribution warehouses along the Mississippi River; pipe and tube went principally to oil industry users along the Gulf Intercoastal Waterway and to Houston. Local waterborne movements of 1.5 million tons included 551 thousand tons of plates and sheets of which the major part went to fabricating plants in Louisville and Cincinnati.

Iron ore, steel and iron products are generally transported by rail and truck. In the United States, in 1972, approximately 51 percent of steel mill products were transported by truck, 43.7 percent by rail, and 5.5 percent by water. The low use of water transport is attributed mainly to its longer shipping time and consequent increased inventory cost. In addition, the volume of individual shipments is often not sufficient to make barge transport feasible.

Generally, waterway movements are projected to follow the current modal pattern. An exception was made to account for the planned use of water transport for about 30 percent of scrap requirements for two large new electric furnaces in the Pittsburgh area.

Gross waterborne shipments of iron ore, steel and iron commodities in the ORS are expected to increase at an average annual rate of 2.6 percent between 1976 and 2000 and at 1.7 percent from

2000 to 2040. Outbound waterway shipments from the PSAs are expected to increase at a slower rate than inbound shipments. By the year 2000, total waterway movements are expected to reach 9.4 million tons per year. By 2040, waterway movements are projected to be 18.1 million tons annually.

I. Food and Feed Products

Group IX, food and feed products, nec., consists of prepared animal feeds and animal by-products, and a number of food products ranging from wheat flour to vegetable oils. During the 1969-76 period, these products accounted for not more than 0.6 percent of total Ohio River System (ORS) waterborne traffic. The total inbound, outbound and local Group IX waterborne traffic in the ORS was recorded at 447.4 thousand tons in 1969. This increased to a peak level of 1.3 million tons in 1976.

Historical data indicate that only six products within Group IX may be expected to generate significant future waterborne traffic flows in the ORS. These products are:

- Wheat flour and semolina (WCSC 2041)
- Prepared animal feed (WCSC 2042)
- Grain mill products, nec. (WCSC 2049)
- Sugar (WCSC 2061)
- Molasses (WCSC 2062)
- Vegetable oils, all grades; margarines and shortening (WCSC 2091).

In the 1969-76 period, these six products accounted for between 95 and 99 percent of total food and feed product waterborne movements in the ORS.

The uses of food and feed products vary widely among individual products. Grain mill products, such as soybean meal, are used almost exclusively as animal feed. Most of the wheat produced and consumed domestically is ground for edible flour. Vegetable oils are used mainly in the production of shortening, margarines, and cooking and salad oils. Nonfood uses include use in paints, varnishes, core oils, soaps, and lubricants. Tallow is the general name for heavy fats obtained from the bodies of sheep and cattle. The best grades of internal fats, suet, are used for edible products. External fats are used in lubricants, soaps and candles. Sugar, which can be derived from sugar cane or sugar beets, is most valued as a sweetening agent and a food preservative. Molasses is

the heavy syrup left as a result of sugar crystallization. Edible molasses is a light, purified residual syrup. Blackstrap molasses, the final, heavy, unpurified and inedible syrup is used in the production of ethyl alcohol. In addition to human consumptive and industrial use, molasses is fed to beef and dairy cows.

Between 1969 and 1976, consumption of food and feed products in the PSAs decreased at a slight rate of 0.58 percent per annum. In 1969, 5.1 million tons of food and feed products were consumed by livestock and food processors located in the PSAs. By 1976, this had decreased to 4.9 million tons.

BEA 49 (Nashville) was the largest PSA consumer of food and feed products. Of the 4.86 million tons of food and feed products consumed in the PSAs in 1976, 3.35 million tons, or approximately 70 percent, were consumed by industry in the production of a variety of food and kindred products and nonfood items. Livestock consumption of Group IX products (prepared animal feed and grain mill products) accounted for 1.52 million tons, or approximately 30 percent of total consumption. Over time, this ratio has varied somewhat in favor of industrial consumption as livestock consumption has generally declined.

In addition to local demand for Group IX commodities produced in the PSAs, demand also is generated by Secondary Consumption Areas (SCAs) located outside the ORB. Between 1969 and 1976, BEA 138 (New Orleans) was the most important SCA; and in 1976 this BEA received 750.8 thousand tons of food and feed products. These Group IX shipments consisted mainly of soybean meal and oil destined to export and accounted for more than 37 percent of the group's shipments outbound for the ORS in 1976.

Consumption characteristics of food and feed products are determined by the factors which influence product demand. Among these are product prices, population growth and concentration, changes in disposable income, availability and suitability of substitutable goods, and changes in consumer patterns resulting from changes in taste.

Production of food and feed products in the PSAs increased slightly between 1969 and 1976, at an average rate of 0.72 percent per annum. In 1969, somewhat less than 3.1 million tons of food and feed products were produced in the PSAs. By 1976, Group IX production had increased to more than 3.2 million tons. BEAs 47 (Huntsville) and 48 (Chattanooga) are the largest PSA food and feed

product producers, each accounting for over 30 percent of total production.

The production of Group IX commodities in the PSAs is supplemented by production in Secondary Production Areas (SPAs) located outside the Ohio River Basin.

Between 1969 and 1976, BEA 138 (New Orleans) was the most important SPA shipping Group IX products (mainly molasses, sugar, and vegetable oil) to the ORB. Somewhat less important, but still significant, as Group IX SPAs are BEAs 114 (St. Louis), 103 (Sioux City), 91 (Minneapolis), 113 (Quincy) and 77 (Chicago). These BEAs mainly supply wheat flour, vegetable oils, and grain mill products to the PSAs.

The production characteristics of food and feed products are determined by factors affecting the production of individual products. These include the availability of primary agricultural inputs, product prices, substitutability of other goods, weather, and existing technology.

A gradual but steady increase in total food and feed product consumption in the PSAs is expected, amounting to 1.55 percent per annum between 1976 and 2000, and 1.06 percent per annum between 2000 and 2040. Group IX consumption in the PSAs is expected to be 5.2 million tons in 1980, 7.2 million tons by 2000, and 10.9 million tons by 2040.

BEA, or BEA segment, consumption is expected to remain relatively evenly distributed throughout the area served by the ORS. BEA 49 (Nashville) is expected to remain the largest PSA consumer.

A steady increase in total food and feed products production is expected in the PSAs, amounting to 2.6 percent per annum between 1976 and 2000 and 1.3 percent per annum between 2000 and 2040. Food and feed products production in the PSAs in 1980 is expected to increase, by almost 60 percent over 1976 production, to 4.25 million tons. Group IX production is expected to be 5.10 million tons in 1990, 6.08 million tons in 2000 and 10.04 million tons in 2040.

In the United States, food and feed products are generally transported by truck and, to a lesser degree, by rail. Waterway movements are not common. While this pattern of transport also applies to the area served by the ORS, the convenience of rivers flowing through producing and consuming areas provides some notable exceptions.

Transportation of food and feed products within the PSAs is dominated by truck movements. In 1976, the area served by the ORS was a net receiver of food and feed products by all modes. Of the 1.65 million tons of Group IX products received in the PSAs in 1976, net rail receipts accounted for 751 thousand tons and net truck receipts for 1.22 million tons. There was, however, a net movement of 312.2 thousand tons of Group IX products by water in 1976. In general, the ORS hinterland ships out flour and soybean meal and oil, while importing molasses and sugar via the inland waterway system.

Waterborne movements of food and feed products are relatively important in those BEAs where production and/or consumption takes place near the waterway. In 1976, BEAs 47 (Huntsville), 48 (Chattanooga) and 55 (Evansville) generated the majority of outbound waterborne movements. They are locations of waterside Group IX product producers. BEAs 47 (Huntsville) and 62 (Cincinnati) generated the majority of inbound waterborne movements and are locations of food processors located near the water.

As in the case of other commodities, the choice of mode for the transportation of food and feed products is influenced by the transport rates and time implicit in the location of consumption and production areas. Inherent in any modal choice is an appropriate origin and destination pair, as well as the existence of the necessary facilities and equipment, such as tank cars for moving vegetable oils.

The modal split of each PSA in the ORB is not expected to shift dramatically. In general, those BEAs or BEA segments that have historically been either large outbound or inbound waterway shippers or receivers [i.e., BEAs 47 (Huntsville), 48 (Chattanooga) and 55 (Evansville) and BEAs 47 and 62 (Cincinnati)] are expected to maintain their relative importance. The same is true for rail shippers and/or receivers.

The average annual growth rate of net waterborne food and feed product shipments is projected to be 4.5 percent between 1976 and 2000 and 1.4 percent between 2000 and 2040. Outbound waterborne shipments are expected to increase at a rate of 2.7 percent per annum between 1976 and 2000. Inbound movements are expected to increase only slightly between 1976 and 2000. Local movements are expected to remain relatively small. They are projected to grow at an annual rate of 2.5 percent between 1976 and 2000 and at a rate of 1.0 percent between 2000 and 2040.

The total (gross) waterborne shipments will reach 3.40 million tons in 2040 as compared to 1.27 million tons in 1976. Waterborne food and feed products are expected to continue to be relatively insignificant in the ORS in the future.

J. Wood and Paper

Group X, wood and paper products, consists of forest products ranging from wood logs and furniture to paper and printed products. The individual products within this group which account for nearly all shipments in the group are: pulpwood logs; lumber products; and paper products, including pulp, standard newsprint paper, paper and paperboard, and pulp paper and paperboard products, nec. During the period 1969-76, Group X products accounted for an average of only 0.4 percent of total Ohio River System (ORS) traffic. Most of this was local.

Lumber. Major uses of lumber are residential and other construction, the manufacture of furniture, and railroad crossties, wood pallets and containers. Demand for lumber is derived from final product demand and depends primarily on income and population. Because of the importance of residential construction in lumber use, family size and age of head of household are important determinants of lumber demand. Relative prices and availability of substitutes tend to affect lumber demand in the long run.

Pulpwood Logs. Pulpwood logs are used almost exclusively for the production of paper products, and demand for pulpwood logs derives, consequently, from the demand for paper products.

Paper Products. Paper products are used for various purposes ranging from paper as an intermediate product in the printing and publishing industries to household tissues. Included also are writing and related papers, packaging paper, Kraft linerboard, building board (including insulation board and hardboard), and various other paper products. In general, low cost substitutes are not as available for paper products as they are for other Group X products.

Consumption of wood and paper products in the PSAs increased about 20 percent in the period 1969-76, from 11.0 million tons to 13.2 million tons. This increase followed the national trend.

Lumber consumption increased only modestly from 1969 to 1976. The largest consuming PSAs were metropolitan areas such as BEAs 62

(Cincinnati) and 54 (Louisville). BEA 48 (Chattanooga) is a significant consumer of lumber because of furniture and wood production. Consumption of pulpwood logs increased throughout most of the 1969-76 period. Pulpwood consumption is concentrated at pulp and papermills, particularly in BEA 47 (Huntsville) and in the Tennessee Valley. Consumption of paper products is highest in metropolitan areas such as BEAs 62 (Cincinnati) and 66 (Pittsburgh).

Production of wood and paper products in the PSAs increased from 4.8 million tons in 1969 to 5.8 million tons in 1976, an average increase of 2.6 percent per year. Lumber, pulpwood logs, and paper products contributed about equally to the total. BEAs 47 (Huntsville) and 48 (Chattanooga) alone accounted for about 70 percent of production in the PSAs throughout the period. Lumber production in the PSAs increased steadily throughout 1969-76, in contrast to a decline associated with the 1974-75 recession experienced elsewhere in the United States. Production of pulpwood logs is concentrated in the Huntsville and Chattanooga BEAs. Pulp and paper production requires large amounts of water, so mills are frequently located near waterways. The Tennessee Valley has a large and growing paper producing area, particularly BEAs 47 (Huntsville), 48 (Chattanooga), and 50 (Knoxville). In recent years, paper mills have also been established in Kentucky.

Wood and paper product consumption in relevant BEAs, and in the Tennessee Valley area in general, is expected to grow substantially during the coming decades. The average annual change in Group X consumption for 1976-90 is projected to be 4.01 percent. In later years, the growth rate is expected to decline, with the overall increase between 1976 and 2040 at 2.36 percent per year. Total consumption of Group X commodities in 2040 is projected at 59 million tons. The housing industry is projected to be the largest wood-using industry by the turn of the century. Paper products consumption, and consequently, pulpwood log consumption, are also expected to grow rapidly. The Huntsville and Knoxville BEAs are expected to be the largest consumers of wood and paper products.

The production of wood and paper products in the ORB is also projected to grow rapidly in the future, although at a somewhat slower rate than consumption. Total production of Group X commodities in 2040 is expected to reach 20.8 million tons, an average increase of 2.02 percent per year for 1976-2040. The largest producing PSAs will continue to be BEAs 47 (Huntsville), 48 (Chattanooga), and 50 (Knoxville).

Wood and paper products are generally transported by truck and rail in the ORB as elsewhere in the United States, but the convenience of ORS waterways provides some exceptions. Barge transport has an absolute advantage over other modes for products both produced and consumed along the Tennessee River, such as pulpwood logs. A significant portion of wood products produced in the PSAs is sent by rail to metropolitan areas in Illinois, Indiana, and Ohio, and to the East Coast for consumption and export.

Projections of waterborne movements were based on the existing modal split. Gross waterborne shipments of Group X commodities are projected to increase from 564 thousand tons in 1976 to 1.4 million tons in 2040, at a rate of 1.9 percent per year from 1976 to 2000 and 1.2 percent per year thereafter. Local shipments will continue to dominate, although the most rapid growth, initially, will be in outbound movements.

K. Petroleum Products, Nec.

Group XI, petroleum products, nec., consists of relatively low gravity petroleum products which are not suitable for pipeline transport. The three product groups included are lubricating oils and greases; naphthas; and asphalt, tar, and pitches. All are by-products of petroleum fuel production and are used predominantly in the industrial and transportation sectors.

Consumption of Group XI products in the PSAs was 2.7 million tons in 1969 and 2.9 million tons in 1976. During that period, it rose to a peak of 3.2 million tons in 1973. The year-to-year changes in consumption in the PSAs paralleled changes in national consumption, with the ORB's share remaining between 5 and 6 percent throughout. The demand for petroleum products is influenced by the importance and growth of the petrochemical industry, by growth in the demand of household use of paints and cleaning agents, and by the technological change and growth in the transportation sector. The largest consuming PSAs for Group XI products are BEAs 62 (Cincinnati) and 66 (Pittsburgh).

Production of petroleum products, nec., in the PSAs remained stable during the period 1969-76, with annual production levels ranging from 980.9 thousand tons in 1969 to 1,102.2 thousand tons in 1974. Production in 1976 was 1,026.9 thousand tons. National production during this period was also relatively stable, with the ORB's share remaining at 2 percent. In recent years newly developed technology has improved the efficiency of producing petroleum fuel so that by-product production per barrel of crude oil has

been reduced. However, an offsetting trend is the increasing use of heavy and high-sulfur crude oils which yield a higher volume of petroleum products. BEA 52 (Huntington) is the major producing PSA for petroleum products, accounting for 57 percent of the total production in the PSAs in 1976.

Both consumption and production are projected to increase in the near term. However, they are projected to decline in the long run because of the shortage of crude oil. Consumption is projected to increase from 2.9 million tons in 1976 to 5.3 million tons in 2000 and then decline to 3.1 million tons in 2040. For the entire period 1976-2040, the projection indicates an increase of 0.13 percent per year. The projection of production follows a similar pattern, rising from 1.0 million tons in 1976 to 2.1 million tons in 2000 and then falling to 0.9 million tons in 2040. For the entire period 1976-2040 this indicates a decline in production of 0.13 percent per year.

In the PSAs, net waterborne receipts (inbound less outbound) totaled 1.9 million tons in 1976. Petroleum products include mostly low-value-to-weight products which are not easily damaged. Barge rates average about one-half of rail rates and one-eighth of truck rates, so when there is a convenient waterway between the consumption and production locations, barges are usually the the preferred mode of transport.

In general, no significant changes in the modal split are anticipated in the projection period. However, in some cases BEA-to-BEA links have been adjusted for projected changes in consumption and production location patterns. Gross waterborne traffic is projected to increase from 2.8 million tons in 1976 to 6.0 million tons in 2000. In the following decades, because of the effects of declining crude oil supplies, gross waterborne traffic is projected to decrease rapidly to 3.5 million tons in 2040.

L. Rubber, Plastic and Nonmetallic Mineral Products, Nec.

Group XII, rubber, plastic and nonmetallic mineral products, nec. (including glass and leather), accounted for 0.8 percent of the waterborne traffic in the Ohio River System (ORS) during the period 1969-76. Building cement and lime together accounted for 98.0 percent of Group XII movements in 1976, and the projections are based on analysis of these two commodities.

Cement. Building, or hydraulic, cement is the major binding agent used in concrete construction. Approximately 95 percent of

building cement is portland cement, of which 66 percent is used by producers of ready-mix concrete. Most of the remainder is used by concrete product producers and highway and other contractors.

Lime. Lime, a basic chemical, is used in chemical production, construction, steel production, water purification and air emission control. The steel industry is the primary industrial user, where lime is utilized for open-hearth steel furnaces.

Consumption of lime and cement in the ORB fluctuated from year to year over the period 1969-76, declining overall from 7.7 million tons in 1969 to 7.3 million tons in 1976. The pattern of variation and decline reflected that of national consumption; although the ORB's share of national consumption declined slightly from 8.1 percent to 7.9 percent. Cement and lime are consumed throughout the PSAs. Cement consumption depends on construction activity which in turn is related to economic conditions, population shifts, and government policy. Most of the demand for lime is derived from the demand for specific chemical products and steel. Consumption of lime has been encouraged by environmental controls on synthetic soda ash production (since lime is needed in natural soda ash production) and by the growth of pollution control processes requiring lime.

During the period 1969-76, production of cement and lime in the PSAs varied from 3.6 to 4.5 million tons, with the lowest levels occurring in 1970 and 1975 and a peak of 4,491.0 thousand tons in 1973. This pattern conformed to variations in national production during the period. The leading PSA producer of lime and cement in 1976 was BEA 66 (Pittsburgh) followed by BEAs 54 (Louisville) and 115 (Paducah). Two lime plants began operations in BEA 62 (Cincinnati) during the study period.

Both consumption and production of cement and lime in the PSAs are projected to increase in the next decades. Consumption is expected to rise from 7.3 million tons in 1974-76 to 28.5 million tons in 2040, at an average annual rate of 4.1 percent through 2000 and then at 0.9 percent annually. Production is expected to increase at 3.8 percent annually and then 0.6 percent annually for the same periods, reaching 13.5 million tons in 2040.

In 1972, 15.1 percent of cement shipments in the United States of over 25 miles was shipped by rail, 15.9 percent by water, and the rest by motor carrier and private truck. Because cement has a low price relative to weight, barge is the preferred mode of transport when both origins and destinations are served by water. However, when delivery is required within a short span of time, rail

or truck is the major means of shipment. Only 2 to 4 percent of lime production moved by water during the past decade. Both rail and truck transportation were used extensively.

Net truck receipts are expected to continue to account for the largest portion of net receipts of Group XII commodities in the future, although net water receipts are projected to increase slightly faster than either truck or rail. Gross waterborne shipments are projected to increase at 4.9 percent per year from 1976 to 2000 and at 1.1 percent from 2000 to 2040, reaching 7.0 million tons in 2040. The largest increase will be local shipments in 1976-2000, as the two new lime plants in BEA 62 (Cincinnati) increase production to capacity.

M. Nonferrous Metals and Alloys, Nec.

Group XIII, nonferrous metals and alloys, nec., consists of primary smelter products and semi-fabricated products, such as sheets, bars, castings and wire, and other mill and foundry products. There are four categories of these products: (1) aluminum and aluminum alloys, unworked; (2) copper and copper alloys, whether or not refined, unworked; (3) lead and zinc industry alloys, unworked; and (4) other nonferrous metals and alloys. Group XIII accounted for only 0.1 percent of the total waterborne commerce in the ORS in 1976. Nearly all of this was in the first three categories.

Aluminum and Alloys. Aluminum is the most common metallic element on the earth and is second only to steel in use. Major end-use markets of aluminum include building construction, transportation, consumer durables, electrical machinery and equipment, containers, and packaging. Aluminum is widely used and valued especially for its lightness, nontoxicity, and ease in forming.

Copper and Copper Alloys. Uses of copper are similar to those of aluminum. End uses include building construction, transportation, industrial machinery and equipment, and electrical and electronic products. The volume of waterborne copper products in the ORS is relatively small, but it increased dramatically during the study period from 1.7 thousand tons in 1969 to a peak of 50.3 thousand tons in 1975. Waterborne copper shipments in 1976 were 20.8 thousand tons.

Lead and Zinc and Their Alloys. Lead is used both as a metal to alloy with other elements and as a chemical to form chemical compounds. Transportation related industries are by far the

largest lead-consuming industries, with production of storage batteries and antiknock gasoline additives the primary uses. Zinc is widely used in galvanizing because of its low melting point and good resistance to corrosion. The construction and transportation industries are the major zinc consumers. Waterborne shipments in the ORS of lead and zinc and their alloys consisted almost entirely of primary metals. The volume increased moderately from 37.0 thousand tons to 81.3 thousand tons from 1969 to 1976, but the increase did not keep pace with the increases in other Group XIII commodities.

Other Nonferrous Metals and Alloys. Primary smelter products of other nonferrous metals, such as tin, magnesium, nickel, and chromium, were not significant in volume of waterborne shipments, accounting for less than 1 percent of Group XIII in 1976.

Consumption of nonferrous metals and alloys in the ORB is estimated at 1.3 million tons in 1969 and 1.5 million tons in 1976. This modest increase reflects the limited growth of consuming industries in the PSAs during the period. Year-to-year changes in consumption followed the pattern of consumption for the United States as a whole, particularly a decline in 1975 following the oil embargo. Consumption of nonferrous metals in the PSAs was 6.7 percent of the United States total in 1969 and 7.2 percent in 1976.

Aluminum was the leading nonferrous metal consumed in the PSAs both as a primary metal and in mill and foundry products. BEAs 52 (Huntington) and 55 (Evansville) together accounted for 59.0 percent of primary aluminum consumption in the PSAs in 1976; consumption of mill and foundry products was more widely dispersed, but a major share was consumed in the industrial centers of Cincinnati, Pittsburgh, Nashville, and Evansville.

As a producer of nonferrous metals and alloys, the ORB was considerably more important. Production in the PSAs increased from an estimated 1.8 million tons in 1969 to 2.8 million tons in 1976. During that time, the PSAs' share of national production increased from 11.1 percent to 16.8 percent. The PSAs' share of aluminum production alone was 22.9 percent in 1976.

Production of nonferrous metals and alloys in the ORB is concentrated in six PSAs. These are: BEAs 55 (Evansville), 66 (Pittsburgh), 50 (Knoxville), 52 (Huntington), 48 (Chattanooga), and 49 (Nashville). In 1976, primary metal production accounted for 67 percent of the total, and the remaining 33 percent was mill and foundry products (aluminum and copper). Aluminum predominated

in both categories, accounting for close to 85 percent of total nonferrous metal production in the PSAs. The analysis of production was focused on aluminum.

Aluminum production as a primary metal is concentrated in a few large, vertically integrated firms, primarily because production is capital intensive with favorable economies of scale. Increasing imports of aluminum are an indication that demand is not a constraint on production. Aluminum production does not create serious pollution of the environment, but it is a high energy use industry.

Mill and foundry production is more dispersed, with several hundred independent fabricators throughout the United States. Unlike primary aluminum production, production of semi-fabricated products has exceeded domestic demand, and exports have increased in the last decade.

Production of nonferrous metals in the ORB is expected to increase rapidly in the future from 2.8 million tons in 1976 to 25.2 million tons in 2040. The rate of increase is projected at 5.5 percent per year from 1976 to 2000 and 2.4 percent from 2000 to 2040. Aluminum production is expected to continue to grow rapidly, accounting for an even larger share of total nonferrous metal production than the current 84 percent. The PSA share of U.S. production is expected to rise from 16.8 percent in 1976 to 28.1 percent in 2040.

Consumption of Group XIII products in the PSAs is expected to grow at a somewhat slower rate, 3.8 percent per year from 1976 to 2000 and 2.0 percent from 2000 to 2040. This growth is about in line with projected United States consumption, so that the PSAs' share is expected to remain at around 7 percent.

Waterborne transport accounts for only a small portion of Group XIII shipments, both in the ORB and nationally. In 1972, water transport accounted for 0.7 percent of nonferrous metal shipments in the United States, while rail and motor carrier were 45.9 percent and 53.1 percent, respectively. In 1976, waterborne shipments in PSAs consisted of 215 thousand tons inbound, 11 thousand tons outbound, and 21 thousand tons locally. Virtually all of the waterborne shipments were primary metals rather than semi-fabricated products. Water transport is relatively attractive for the primary metals because they are heavy, bulky, and do not require special handling. Also, the destinations at mill and foundry locations are relatively concentrated. Rail and truck transports,

however, are more suitable for the dispersed destinations of the semi-fabricated products. Truck and rail also have a cost advantage from faster delivery time, which allows lower inventory cost than water transport.

Projections of waterborne transport of Group XIII commodities in the ORS are based on the assumption that the current modal split will continue. Inbound waterborne shipments are expected to continue to be greater than outbound shipments and to increase at a somewhat more rapid rate. The total volume of nonferrous waterborne shipments in the ORS is projected to increase from 246.9 thousand tons in 1976 to 633.1 thousand tons in 2000 and 1,567.8 thousand tons in 2040, at rates of 4.0 percent per year in the first period and 2.3 percent per year in the latter period.

N. Manufactured Products, Nec.

Group XIV, manufactured products, nec., consists of fabricated metal products, machinery, transportation equipment, and other manufactured products. Waterborne shipments of this group in the Ohio River System (ORS) were small throughout the 1969-76 study period, accounting for only 0.2 percent of total waterborne traffic in 1976. Although the group includes a variety of commodities, only four product groups are significant in waterborne traffic. These are: fabricated metal products, machinery, electrical machinery, and ships and boats.

Consumption of selected manufactured goods in Group XIV increased at an average of 8.3 percent per year from 1969 to 1976 in the PSAs. These products are consumed by all sectors of the economy for a variety of uses but the manufacturing sector is by far the largest consumer. BEAs 62 (Cincinnati) and 66 (Pittsburgh) were the major consuming areas during the period; BEAs 48 (Chattanooga) and 65 (Clarksburg) were the fastest growing.

The Ohio River Basin has long been an industrial center of the nation, and it is expected to remain so. Production of selected manufactured products in the PSAs fluctuated during the 1969-76 period, ranging from a low of 6.6 million tons in 1971 to a high of 8.0 million tons in 1974. Production in 1976 was 7.4 million tons. In 1976, almost 62 percent of the total PSA production occurred in BEAs 54 (Louisville), 62 (Cincinnati), and 66 (Pittsburgh).

Consumption of Group XIV products in the PSAs is projected to increase at 3.7 percent per year from 6.0 million tons in 1974-76

to 14.6 million tons in 2000. In the following decades the increase is projected to be at 2.3 percent per year, reaching a total of 35.9 million tons in 2040. Production in the PSAs is also expected to rise rapidly, at 4.0 percent per year in the first projection period and then at 2.2 percent per year. Production in 2040 is projected at 48.0 million tons.

Truck is the primary transportation mode for manufactured products. Shippers and receivers of these products prefer rapid means of transport rather than leaving expensive machinery and products to be nonproductive for long periods of time. Moreover, many markets for manufactured products are local, and truck is therefore often the least expensive mode of transport. Gross water shipments in the PSAs were 352 thousand tons in 1976. Gross rail shipments were 2,865 thousand tons, and gross truck movements were probably several times larger, but actual data are not available.

Projections of waterborne transport of Group XIV products were based on the 1976 modal pattern. Net shipments by all modes are expected to increase substantially, reflecting the more rapid growth of production than consumption. Gross waterborne shipments are projected to increase at 4.3 percent per year from 1976 to 2000 and at 2.1 percent from 2000 to 2040, totaling 2.2 million tons in 2040.

O. Others, Nec.

Group XV, others, nec., consists of a large number of commodities which are generally insignificant in terms of their waterborne movements. These commodities have few common consumption, production or transportation characteristics.

There are 33 individual commodities in Group XV, ranging from live animals to Department of Defense cargo. Only three commodities have been transported in the Ohio River System with any regularity: petroleum and coal production, nec., slag, and government materials (primarily waterway improvement materials).

In 1976, 4.3 million tons of Group XV materials shipped in the ORS, of which 91 percent was waterway improvement materials. Most waterway improvement materials shipped in the ORS were produced in BEA 115 (Paducah) and destined for areas outside the ORB.

Consumption of the three major Group XV commodities in the PSAs fluctuated within the range of 4.5 to 5.9 million tons during

the period 1969-76. Petroleum and coal products accounted for 2.5 to 3.1 million tons, followed by slag consumption which accounted for 1.7 to 2.0 million tons. The remainder was waterway improvement material. The major consuming PSA was BEA 66 (Pittsburgh) which was the prime consumer of petroleum and coal products.

Production of the major Group XV commodities averaged 16 million tons during the 1969-76 period. In 1976, 15.3 million tons were produced, of which 61.7 percent was slag, a by-product of the steel manufacturing process. BEA 66 (Pittsburgh) accounted for almost 80 percent of slag production in the PSAs. Nearly 3.7 million tons of waterway improvement materials were produced in the PSAs in 1976. Over 99 percent of this production occurred in BEA 115 (Paducah).

The production-consumption gap in the PSAs, which resulted in a relatively high level of outbound shipments in the past decade is projected to remain. Consumption is projected to grow slowly at an average annual rate of 0.66 percent, while production will grow at a slightly lower level. By the year 2000, consumption in the PSAs will total 6.6 million tons, while production will equal 16.3 million tons.

Approximately one-third of the transportation of Group XV products in the area served by the ORS is by water. This is a relatively large proportion compared to other products and commodities. The reasons are that these products have relatively low value to weight ratios; they are not easily damaged; and they are usually not required to reach destination points in a short time.

The gross waterborne movements of others, nec., are projected to increase from 4.3 million tons in 1976 to 5.1 million tons in 2040. Most of this increase is attributable to the inbound shipments of miscellaneous petroleum products.

APPENDIX A

Table A-1. Ohio River Basin Study: Waterborne Commerce Statistics Code Classifications by Commodity Group

Group I: Coal and Coke - 1121, 2920, 3313

1121	Coal and lignite.
2920	Coke, including petroleum coke.
3313	Coke (coal and petroleum), petroleum pitches and asphalts, and naphtha and solvents.

Group II: Petroleum Fuels - 2911-15, 2921

2911	Gasoline, including natural gasoline.
2912	Jet fuel.
2913	Kerosine.
2914	Distillate fuel oil.
2915	Residual fuel oil.
2921	Liquefied petroleum gases, coal gases, natural gas, and natural gas liquids.

Group III: Crude Petroleum -1311

1311	Crude Petroleum.

Group IV: Aggregates - 0931, 1411-1442

0931	Marine shells, unmanufactured.
1411	Limestone flux and calcareous stone.
1412	Building stone, unworked.
1442	Sand, gravel and crushed rock.

Group V: Grains - 0102-0111

0102	Barley and rye
0103	Corn
0104	Oats
0105	Rice
0106	Sorghum
0107	Wheat
0111	Soybeans

(Continued)

Table A-1. (Continued)

Group VI: Chemicals and Chemical Fertilizers - 2810-2891

2810	Sodium hydroxide (caustic soda).
2811	Crude products from coal tar, petroleum, and natural gas, except benzene and toluene.
2812	Dyes, organic pigment, dyeing and tanning materials.
2813	Alcohols.
2816	Radioactive and associated materials, including wastes.
2817	Benzene and toluene, crude and commerically pure.
2818	Sulfuric acid.
2819	Basic chemicals and basic chemical products, not elsewhere classified (nec.).
2821	Plastic materials, regenerated cellulose and synthetic resins, including film, sheeting, and laminates.
2822	Synthetic rubber.
2823	Synthetic (man-made) fiber.
2831	Drugs (biological products, medicinal chemicals, botanical products and pharmaceutical preparations).
2841	Soap, detergents, and cleaning preparations; perfumes, cosmetics and other toilet preparations.
2851	Paints, varnishes, lacquers, enamels, and allied products.
2861	Gum and wood chemicals.
2871	Nitrogenous chemical fertilizers, except mixtures.
2872	Potassic chemical fertilizers, except mixtures.
2873	Phosphatic chemical fertilizers, except mixtures.
2876	Insecticides, fungicides, pesticides, and disinfectants.
2879	Fertilizers and fertilizer materials, not elsewhere classified.
2891	Miscellaneous chemical products.

Group VII: Ores and Minerals - 1021-1091; 1451; 1491-1499

1021	Copper ore and concentrates.
1051	Bauxite and other aluminum ores and concentrates.
1061	Manganese ores and concentrates.
1091	Nonferrous metal ores and concentrates, not elsewhere classified.
1451	Clay, ceramic and refractory materials.
1491	Salt.
1492	Sulphur, dry.

(Continued)

Table A-1. (Continued)

Group VII:	Ores and Minerals - continued
1493	Sulphur, liquid.
1494	Gypsum, crude and plasters.
1499	Nonmetallic minerals, except fuels, not elsewhere classified.
Group VIII:	Iron Ore, Steel and Iron - 1011, 3311; 3314-3319; 4011
1011	Iron ore and concentrates.
3311	Pig iron.
3314	Iron and steel ingots, and other primary forms including blanks for tube and pipe, and sponge iron.
3315	Iron and steel bars, rods, angles, shapes and sections, including sheet piling.
3316	Iron and steel plates and sheets.
3317	Iron and steel pipe and tube.
3318	Ferroalloys.
3319	Primary iron and steel products, not elsewhere classified, including castings in the rough.
4011	Iron and steel scrap.
Group IX:	Feed and Food Products, Nec. - 2014-2099
2014	Tallow, animal fats and oils.
2015	Animal by-products, not elsewhere classified.
2021	Dairy products, except dried milk and cream.
2022	Dried milk and cream.
2031	Fish and fish products, including shellfish, prepared or preserved.
2034	Vegetables and preparations, canned and otherwise prepared and preserved.
2039	Fruits and fruit vegetable juices, canned and otherwise prepared or preserved.
2041	Wheat flour and semolina.
2042	Prepared animal feeds.
2049	Grain mill products, not elsewhere classified.
2061	Sugar.
2062	Molasses.
2081	Alcoholic beverages.
2091	Vegetable oils, all grades; margarine and shortening.
2092	Animal oils and fats, not elsewhere classified, including marine.
2094	Groceries.
2095	Ice.
2099	Miscellaneous food products.

(Continued)

Table A-1. (Continued)

Group X: Wood and Paper Products - 2411-2711; 0861

2411	Logs.
2412	Rafted logs.
2413	Fuel wood, charcoal, and wastes.
2414	Timber, posts, poles, piling, and other wood in the rough.
2415	Pulpwood log.
2416	Wood chips, staves, moldings, and excelsior.
2421	Lumber.
2431	Veneer, plywood, and other worked wood.
2491	Wood manufactures, not elsewhere classified.
2511	Furniture and fixtures.
2611	Pulp.
2621	Standard newsprint paper.
2631	Paper and paperboard.
2691	Pulp, paper and paperboard products, not elsewhere classified.
2711	Printed matter.
0861	Forest products, not elsewhere classified.

Group XI: Petroleum Products, Nec. - 2916-2918

2916	Lubricating oils and greases.
2917	Naphtha, mineral spirits, solvents, not elsewhere classified.
2918	Asphalt, tar, and pitches.

Group XII: Rubber, Plastic, Nonmetallic Mineral Products, Nec. - 3011-3291

3011	Rubber and miscellaneous plastics products.
3111	Leather and leather products.
3211	Glass and glass products.
3241	Building cement.
3251	Structural clay products, including refractories.
3271	Lime.
3281	Cut stone and stone products.
3291	Miscellaneous nonmetallic mineral products.

(Continued)

Table A-1. (Continued)

Group XIII: Nonferrous Metals and Alloys, Nec. - 3321-3324.

3321	Nonferrous metals primary smelter products, basic shapes, wire, castings and forgings, except copper, lead, zinc and aluminum.
3322	Copper and copper alloys, whether or not refined, unworked.
3323	Lead and zinc including alloys, unworked.
3324	Aluminum and aluminum alloys, unworked.

Group XIV: Manufactured Products, Nec.- 3411-3911.

3411	Fabricated metal products, except ordnance, machinery, and transportation equipment.
3511	Machinery, except electrical.
3611	Electrical machinery, equipment and supplies.
3711	Motor vehicles, parts and equipment.
3721	Aircraft and parts.
3731	Ships and boats.
3791	Miscellaneous transportation equipment.
3811	Instruments, photographic and optical goods, watches and clocks.
3911	Miscellaneous products of manufacturing.

Group XV: Others, Nec.

0101	Cotton, raw.
0112	Flaxseed.
0119	Oilseeds, not elsewhere classified.
0121	Tobacco, leaf.
0122	Hay and fodder.
0129	Field crops, not elsewhere classified.
0131	Fresh fruits and tree nuts, except bananas and plantains.
0132	Bananas and plantains.
0133	Coffee, green and roasted, (including instant).
0134	Cocoa beans.
0141	Fresh and frozen vegetables.
0151	Live animals (livestock), except zoo animals, cats, dogs, etc.
0161	Animals and animal products, not elsewhere classified.
0191	Miscellaneous farm products.
0841	Crude rubber and allied gums.

(Continued)

Table A-1. (Continued)

Group XV:	Others, Nec. - continued
0911	Fresh fish, except shellfish.
0912	Shellfish, except prepared or preserved.
0913	Menhaden.
1471	Phosphate rock.
1479	Natural fertilizer materials, not elsewhere classified.
1911	Ordnance and accessories.
2211	Basic textile products, except textile fibers.
2991	Petroleum and coal products, nec.
3312	Slag.
4012	Nonferrous metal scrap.
4022	Textile waste, scrap and sweepings.
4024	Paper waste and scrap.
4029	Waste and scrap, nec.
4111	Water.
4112	Miscellaneous shipments not identifiable by commodity.
4113	LCC freight.
4118	Materials used in waterway improvement, government materials.
9999	Department of Defense controlled cargo and special category items.

APPENDIX B

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Table B-1. Ohio River Basin: Total Coal Production by BEAs or BEA Segments[a], 1969-76
(Thousands of tons unless otherwise specified)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change
Primary Study Areas	419,206	446,265	397,707	418,883	411,747	406,863	429,228	436,998	0.60
BEA 47: Huntsville, AL	--	--	21	20	--	--	150	203	b
BEA 48: Chattanooga, TN	1,374	2,254	2,321	2,591	1,596	1,753	1,506	2,452	8.63
BEA 49: Nashville, TN	556	935	1,612	875	618	688	1,109	1,395	14.04
BEA 50: Knoxville, TN	17,679	19,836	23,708	24,837	24,946	25,928	29,126	26,671	6.05
BEA 51: Bristol, VA	53,345	52,567	44,839	49,025	47,810	45,849	47,343	51,265	(0.57)
BEA 52: Huntington, WV	102,752	109,052	91,776	92,232	91,228	90,738	91,891	97,813	(0.70)
BEA 53: Lexington, KY	21,051	26,734	25,484	22,951	26,338	27,638	31,727	33,829	7.01
BEA 54: Louisville, KY	--	--	--	--	--	--	40	11	b
BEA 55: Evansville, IN	65,182	70,363	63,992	72,659	73,066	71,100	76,452	73,564	1.74
BEA 62: Cincinnati, OH	--	--	--	--	--	--	--	--	--
BEA 64: Columbus, OH	11,318	13,825	13,048	12,465	10,646	11,328	11,918	13,345	2.38
BEA 65: Clarksburg, WV	36,595	37,457	32,279	33,211	30,773	29,227	31,388	30,367	(2.63)
BEA 66: Pittsburgh, PA	107,811	111,536	97,046	106,559	103,611	101,629	105,564	104,777	(0.41)
BEA 68: Cleveland, OH	1,523	1,690	1,565	1,451	1,110	980	1,013	1,306	(2.17)
BEA 115: Paducah, KY	20	16	16	7	5	5	1	--	b

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.
b. No production in 1969 and/or 1976.

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1969-75 eds. Totals for 1976 from: Alabama Department of Industrial Relations, Annual Statistical Report, 1975-76 eds.; Tennessee Department of Labor, Annual Report, 1976 ed.; Kentucky Department of Mines and Minerals, Annual Report, 1976 ed.; West Virginia Department of Mines, Annual Report and Directory of Mines, 1976 ed.; Ohio Department of Industrial Relations, Division of Mines Report, 1976 ed.; Pennsylvania Geological Survey, Bituminous Coal Region Report, 1976 ed.; Illinois Department of Mines and Minerals, Annual Coal, Oil and Gas Report, 1977 ed.; Indiana Geological Survey, Coal Production, 1976 ed.; Maryland Bureau of Mines, Annual Report, 1976 ed.; and correspondence with the Georgia Department of Natural Resources.

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Table B-2. United States and Ohio River Basin: Production of Petroleum Fuels, BEAs or BEA Segments[a], Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	497,678.2	519,470.1	535,085.2	560,871.1	598,922.2	574,035.8	591,581.7	635,320.9
Primary Study Areas	14,096.3	13,880.4	13,680.8	14,076.1	14,570.0	15,156.8	16,376.9	15,841.7
BEA 47: Huntsville, AL	--	--	--	--	--	--	--	--
BEA 48: Chattanooga, TN	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	--	--	--	--	--	--	--	--
BEA 50: Knoxville, TN	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV	4,366.9	4,918.3	5,518.5	5,261.6	5,068.3	5,147.3	5,695.0	5,536.7
BEA 53: Lexington, KY	--	--	--	--	--	--	106.0	125.4
BEA 54: Louisville, KY	768.0	825.1	989.3	1,050.2	984.8	994.6	1,177.0	1,035.0
BEA 55: Evansville, IN	5,738.0	5,312.4	4,707.6	4,852.9	5,495.0	5,819.2	6,089.1	5,842.0
BEA 62: Cincinnati, OH	2,387.0	2,345.7	2,361.9	2,691.0	2,625.7	2,671.7	2,861.5	2,845.7
BEA 64: Columbus, OH	836.4	478.9	103.5	124.2	125.1	174.3	170.5	146.3
BEA 65: Clarksburg, WV	--	--	--	--	--	--	--	--
BEA 66: Pittsburgh, PA	--	--	--	96.2	271.1	349.7	337.8	310.6
BEA 68: Cleveland, OH	--	--	--	--	--	--	--	--
BEA 115: Paducah, KY	--	--	--	--	--	--	--	--

Note: Production by BEA and BEA segment based on the ratio of district total fuel output to motor gasoline multiplied by production of motor gasoline by BEA and BEA segment. Production of motor gasoline by BEA and BEA segment based on state motor gasoline figures distributed among BEAs and BEA segment on the basis of the 1969-76 distribution of state gasoline production capacity of operating plants among BEAs and BEA segments. Annual distribution was estimated as the average of distributions obtained for January 1 of each year and the following year. Distribution of capacity in 1969 assumed equal to January 1, 1979 distribution.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Interior, Bureau of Mines, "Crude Petroleum and Petroleum Products," Minerals Yearbook, 1969-76 eds., and from U.S. Department of Interior, Bureau of Mines, "Petroleum Refineries in the United States and Puerto Rico," Mineral Industry Surveys, January 1, 1970-76.

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Table B-3. United States and Ohio River Basin: Production of Crude Petroleum, by BEAS or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	498,043.0	519,564.3	510,179.3	510,394.1	496,440.6	473,055.4	451,518.3	439,613.0
Primary Study Areas	4,507.5	3,887.0	3,453.4	2,980.7	2,539.6	2,299.1	2,168.1	2,153.8
BEA 55: Evansville, IN	4,412.3	3,799.8	3,367.1	2,901.8	2,465.6	2,222.7	2,093.7	2,082.7
BEA 64: Columbus, OH	33.9	34.1	32.4	29.3	26.1	29.1	27.1	27.5
BEA 66: Pittsburgh, PA	61.3	53.1	53.9	49.6	47.9	47.3	47.3	43.6

Note: Crude petroleum production by BEA and BEA segment was prepared from county production data reported for the states of Alabama, Illinois, Indiana, Kentucky, Mississippi, Pennsylvania and Tennessee. Production data at a county level were unavailable for Ohio and West Virginia and were estimated from the distribution of earnings in the oil and gas extraction industry for counties reporting in the Census of Mineral Industries and state production figures obtained from the Bureau of Mines. Georgia and Maryland are not crude petroleum producing states.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1969-76 eds.; Alabama Oil and Gas Board, Production Report: Oil and Gas Fields; Illinois State Geological Survey, County Production of Oil and Gas, 1969-76 eds.; Indiana Department of Natural Resources, Oil Development and Production in Indiana, 1969-72, and 1975-76 eds.; Kentucky State Department of Mines and Minerals, Annual Report, 1969-76 eds.; Mississippi Oil and Gas Board, County Production of Oil and Gas, 1969-76 eds.; Pennsylvania Department of Mines and Minerals, Annual Report, 1970-76 eds.; Tennessee Division of Geology, Oil and Gas Production, 1970-76 eds.; U.S. Department of Commerce, Bureau of the Census, Census of Mineral Industries, 1972 ed.

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Table B-4. Ohio River Basin: Production of Aggregates, by BEAs or BEA Segments[a], Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	122,448.1	114,780.1	115,710.7	121,151.5	146,659.8	132,657.5	123,265.8	127,935.4
BEA 47: Huntsville, AL	4,560.5	4,327.2	4,420.1	4,681.2	6,071.7	5,863.5	5,793.5	6,373.6
BEA 48: Chattanooga, TN	8,429.3	7,472.2	7,116.2	7,015.0	8,447.6	7,601.3	7,013.8	7,238.7
BEA 49: Nashville, TN	13,101.4	12,889.8	13,596.0	14,881.8	19,124.4	18,293.5	17,935.2	19,571.3
BEA 50: Knoxville, TN	7,123.7	7,437.8	8,250.2	9,434.2	11,542.1	10,546.3	9,835.9	10,360.0
BEA 52: Huntington, WV	7,877.3	6,795.0	6,259.9	5,940.5	7,377.0	6,858.4	6,533.1	6,954.4
BEA 53: Lexington, KY	6,207.6	5,899.7	6,017.0	6,384.2	7,641.0	6,831.9	6,274.2	6,433.3
BEA 54: Louisville, KY	16,380.2	15,724.9	16,222.6	17,371.1	20,825.7	18,651.6	17,146.3	17,618.8
BEA 55: Evansville, IN	5,500.7	5,279.9	5,438.4	5,827.4	7,230.3	6,685.9	6,360.5	6,744.1
BEA 62: Cincinnati, OH	17,580.2	16,390.5	16,442.5	17,116.9	20,107.2	17,643.4	15,889.0	15,972.6
BEA 64: Columbus, OH	1,962.9	2,295.6	2,777.1	3,392.1	3,387.8	2,401.1	1,639.4	1,061.5
BEA 65: Clarksburg, WV	1,812.1	1,790.6	1,886.1	2,074.6	2,551.9	2,347.6	2,268.1	2,415.2
BEA 66: Pittsburgh, PA	25,630.2	21,842.6	19,821.3	18,428.5	22,438.9	20,389.4	19,044.5	19,858.4
BEA 68: Cleveland, OH	1,406.5	1,687.3	2,082.8	2,567.2	2,801.2	2,255.2	1,836.7	1,641.5
BEA 115: Paducah, KY	4,875.5	4,947.0	5,380.5	6,036.8	7,113.0	6,261.4	5,645.6	5,692.0

Note: Production by BEAs and BEA segments for 1969, 1972 and 1976 based on RRNA consumption estimates adjusted for inter-BEA rail and water shipments. Production for the entire ORB for other years was determined using linear extrapolations of the ratio of ORB production to consumption obtained for 1969, 1972, and 1976. Production was allocated to BEAs and BEA segments using linear extrapolations of the BEA or BEA segment share of the ORB production. Columns may not equal totals due to rounding.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Table 7, Waterborne Commerce by Port Equivalents, 1969-76, and ICC Railroad Waybill Sample, 1969, 1972, 1976, supplied by U.S. Army Corps of Engineers.

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Table B-5. United States and Ohio River Basin: Production of Grains,[a] by BEAs or BEA Segments,[b] Estimated 1969-76

(Thousands of tons unless otherwise specified)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
United States	208,641.1	190,734.9	241,911.6	240,667.0	255,841.4	221,053.9	273,481.7	278,529.0	4.2
Primary Study Areas	15,964.3	12,785.6	18,653.7	17,817.5	17,927.0	17,862.1	20,699.6	25,576.9	7.0
BEA 44: Atlanta, GA	48.3	33.5	52.1	49.8	53.8	72.9	90.5	87.7	8.9
BEA 45: Birmingham, AL	244.5	206.3	264.8	237.4	278.8	286.5	385.7	418.0	8.0
BEA 46: Memphis, TN	269.7	240.7	356.8	340.8	329.7	337.3	426.3	483.1	8.7
BEA 47: Huntsville, AL	320.4	290.4	430.2	368.7	405.3	449.6	616.4	643.1	10.5
BEA 48: Chattanooga, TN	159.3	122.7	203.6	212.8	237.2	234.1	285.7	378.4	13.2
BEA 49: Nashville, TN	841.6	703.2	1,148.4	1,145.8	1,203.6	1,306.5	1,316.5	1,949.8	12.8
BEA 50: Knoxville, TN	56.9	51.1	70.4	78.3	93.5	79.9	87.0	118.0	11.0
BEA 52: Huntington, WV	73.4	49.1	81.6	77.7	81.6	86.8	97.0	105.4	5.3
BEA 53: Lexington, KY	244.9	192.8	341.1	332.2	341.8	357.8	313.5	427.4	8.3
BEA 54: Louisville, KY	685.0	475.9	813.4	810.0	869.3	929.8	826.6	1,173.7	8.0
BEA 55: Evansville, IN	3,675.7	2,458.2	3,971.5	4,127.3	3,937.5	3,881.5	4,649.1	5,594.6	6.2
BEA 56: Terre Haute, IN	329.0	298.4	408.7	361.2	404.7	288.0	427.1	498.1	6.1
BEA 60: Indianapolis, IN	2,932.0	2,357.3	3,209.7	3,050.5	3,283.4	2,609.1	3,097.3	3,998.0	4.5
BEA 61: Anderson, IN	389.2	327.5	423.9	385.4	430.6	409.4	452.4	600.7	6.4
BEA 62: Cincinnati, OH	1,402.4	1,100.8	1,566.5	1,389.5	1,416.2	1,513.5	1,630.3	2,036.6	5.5
BEA 63: Dayton, OH	1,849.3	1,773.5	2,341.2	2,061.5	2,000.5	2,194.5	2,581.3	2,845.0	6.4
BEA 64: Columbus, OH	1,542.5	1,390.9	1,798.8	1,595.4	1,505.8	1,794.3	1,979.6	2,446.7	6.8
BEA 114: St. Louis, MO	397.8	332.6	495.2	578.8	454.4	397.3	620.9	672.1	7.9
BEA 115: Paducah, KY	502.4	380.6	675.9	614.3	599.0	633.4	816.5	1,100.5	11.9

Note: Individual items may not add to total due to rounding. Data assembled on a county level and aggregated into BEAs and BEA segments.

a. Total production of corn, wheat, and soybeans only. Corn is corn for grain. Wheat is all wheat. Soybeans are soybeans for beans.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Total U.S. production for 1969 to 1974 from U.S. Department of Agriculture, Agricultural Statistics, 1977 and 1978 eds.; data for 1975 and 1976 from U.S. Department of Agriculture, Crop Production: 1977 Annual Summary; Acreage, Yield and Production, January 1978. BEA and BEA segment level data, estimated from production data provided annually for 1969-76 by the U.S. Department of Agriculture Crop Reporting Services of the states of Alabama, Georgia, Illinois, Indiana, Kentucky, Mississippi, Ohio and Tennessee.

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Table B-6. Ohio River Basin: Production of Industrial and Agricultural Chemicals, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons unless otherwise specified)

BEA and BEA segment		1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Primary Study Areas		7,905.5	8,012.1	7,937.8	8,260.4	8,501.3	9,382.4	9,199.0	9,892.0	3.3
BEA 47:	Huntsville, AL	620.2	648.9	671.7	665.3	738.0	904.0	900.2	1,034.6	7.6
BEA 48:	Chattanooga, TN	429.6	401.2	408.8	411.7	419.7	437.9	411.5	450.5	0.7
BEA 49:	Nashville, TN	364.3	348.5	333.2	335.7	344.3	361.0	341.7	375.2	0.4
BEA 50:	Knoxville, TN	113.7	110.2	117.7	170.7	224.6	284.0	311.0	386.5	19.1
BEA 52:	Huntington, WV	1,935.9	1,963.2	1,876.3	1,894.7	1,717.0	1,810.6	1,673.4	1,665.0	(2.1)
BEA 54:	Louisville, KY	1,144.8	1,127.3	1,065.5	1,046.8	1,104.9	1,234.2	1,197.7	1,275.2	1.6
BEA 55:	Evansville, IN	176.6	187.1	192.5	212.6	245.1	325.3	297.8	318.9	8.8
BEA 62:	Cincinnati, OH	1,111.6	1,165.7	1,158.4	1,177.4	1,227.7	1,229.2	1,225.4	1,287.7	2.1
BEA 64:	Columbus, OH	871.2	892.7	940.2	1,031.5	1,046.5	1,157.3	1,169.6	1,259.1	5.4
BEA 66:	Pittsburgh, PA	780.8	806.2	820.8	939.1	1,008.2	1,144.6	1,141.4	1,230.1	6.7
BEA 68:	Cleveland, OH	11.3	11.2	11.2	12.5	13.7	14.2	15.1	16.3	5.4
BEA 115:	Paducah, KY	345.5	349.9	341.5	362.4	411.6	480.1	514.2	592.9	8.0

Note: Production totals for BEAs and BEA segments were derived from 1972 shipments of industrial chemicals, agricultural chemicals and miscellaneous chemicals (SIC 281, 287, 289) 1972 Census of Transportation. Shipment data exclude those shipments moved by pipeline, parcel post shipments, and commodities moved by own power (motorized vehicles, aircraft, etc.), and local shipments (commodities shipped less than 25 miles from the plant). Total shipments of each state were distributed among BEAs and BEA segments according to the percentage distribution of industrial chemical, agricultural chemicals and miscellaneous chemical employment by county in 1972. After 1972, production in each BEA and BEA segment was estimated using changes in chemical employment by state. Production for 1969 and 1970 were estimated by using the rate of change in earnings in chemical and allied products industry, 1972 OBERS Projections.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Shipments from U.S. Department of Commerce, Bureau of the Census, Census of Transportation, 1972 ed. County and state employment data from U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1970-76 eds. Earnings from U.S. Water Resources Council, OBERS Projections, Regional Economic Activity in the U.S., Series E, 1972 ed., Volume II.

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Table B-7. Ohio River Basin: Production of Zinc Ore, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	124.5	118.3	119.3	101.7	64.2	85.7	83.0	82.5
BEA 48: Chattanooga, TN	8.6	8.2	8.2	7.0	4.4	5.9	5.7	5.7
BEA 49: Nashville, TN	27.8	26.4	26.6	22.7	14.3	19.1	18.5	18.4
BEA 50: Knoxville, TN	88.1	83.7	84.5	72.0	45.5	60.7	58.8	58.4

Note: Zinc ore production for Tennessee was obtained from the Bureau of Mines, Minerals Yearbook, 1969-76 eds. The state total was allocated to BEAs or BEA segments within the state utilizing county data for 1976 obtained from the Bureau of Mines, Tennessee liason office. This distribution was applied to the state total for each year.

a. BEA segments are counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1969-76 eds.

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Table B-8. Ohio River Basin: Production of Iron Ore, Iron and Steel, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	78,248.8	72,553.8	68,329.2	76,308.1	86,082.8	84,478.6	62,527.3	67,721.4
BEA 48: Chattanooga, TN	1,199.1	1,040.6	978.6	1,183.6	1,253.7	1,270.5	987.9	1,064.4
BEA 49: Nashville, TN	379.5	327.9	304.9	382.0	396.8	417.6	318.8	340.8
BEA 50: Knoxville, TN	385.4	353.7	332.1	378.1	427.0	430.0	315.6	340.0
BEA 52: Huntington, WV	6,032.7	5,801.4	5,799.7	6,161.3	7,052.5	6,635.6	4,819.0	5,438.4
BEA 54: Louisville, KY	0.4	0.3	0.3	0.4	0.4	0.4	0.3	0.3
BEA 55: Evansville, IN	582.3	523.1	500.1	601.2	638.4	651.4	484.9	528.7
BEA 62: Cincinnati, OH	6,566.1	6,340.3	6,348.5	6,983.5	7,718.5	7,243.8	5,244.4	5,928.9
BEA 64: Columbus, OH	634.0	587.2	529.7	624.9	626.9	584.0	483.6	503.5
BEA 66: Pittsburgh, PA	47,617.1	43,895.4	40,816.7	45,731.6	51,820.4	51,246.2	38,191.8	40,725.2
BEA 67: Youngstown, OH	14,464.1	13,319.9	12,391.8	13,880.8	15,768.5	15,655.0	11,330.6	12,549.3
BEA 115: Paducah, KY	388.1	364.0	326.8	380.7	379.7	344.1	290.4	301.9

Note: Production figures shown include the production of pig iron, steel mill products, ferroalloys, ferrous castings, and ferrous scrap.

a. BEA segments are defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Production of pig iron, steel mill products, ferroalloys, ferrous castings and ferrous scrap are shown annually by BEA segments in Tables A-13 through A-17, respectively (Group VIII Report).

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Table B-9. Ohio River Basin: Production of Food and Feed Products, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons unless otherwise specified)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change 1969-76
Primary Study Areas	3,051.8	3,087.5	3,117.0	3,125.0	3,149.6	3,175.3	3,170.8	3,208.6	0.72
BEA 47: Huntsville, AL	1,042.4	1,054.9	1,065.1	1,065.9	1,076.0	1,086.8	1,085.2	1,098.4	0.75
BEA 48: Chattanooga, TN	1,039.8	1,051.8	1,062.5	1,066.4	1,073.0	1,080.3	1,078.9	1,091.6	0.70
BEA 49: Nashville, TN	143.1	144.7	145.7	146.6	147.6	148.2	148.0	149.7	0.65
BEA 50: Knoxville, TN	40.5	40.9	41.1	41.5	41.7	41.7	41.7	42.1	0.56
BEA 54: Louisville, KY	340.0	344.1	347.5	347.5	351.0	354.8	354.3	358.6	0.76
BEA 55: Evansville, IN	440.2	445.2	449.2	450.9	454.2	457.3	456.7	462.1	0.70
BEA 62: Cincinnati, OH	5.9	5.9	6.0	6.0	6.1	6.1	6.1	6.1	0.48
BEA 66: Pittsburgh, PA	--	--	--	--	--	--	--	--	--

Note: Individual items may not add to total due to rounding. Production of food and feed products was derived for 1976 by multiplying corn, wheat and soybean processing capacity by BEA and BEA segment obtained from Grains (Group V) Report by that percentage share of the processing's end-products which are classified as food and feed products. Percentage shares applied to wheat, soybean and wet processed corn capacities were provided by industry experts. The percentage of dry processed corn that yields food and feed products was derived from the Census of Manufactures, SIC Commodity Code 20413, Corn Mill Products. Wheat processing capacity was multiplied by .67 to derive wheat flour production and by .33 to derive wheat mill feed production. Soybean processing capacity was multiplied by .67 to derive soybean meal production and by .33 to derive soybean oil production. Dry-milled corn processing capacity was multiplied by .4178 to derive corn mill feed production and by .0868 to derive corn oil production. Wet-processed corn capacity was multiplied by .23143 to derive corn mill feed production. No sugar is produced in the study area. Wheat and corn mill feed production and soybean meal production were multiplied by 1.3 to add an additional 30% to the production weight represented by additional commodites (fish protein, phosphates, dried milk, etc.) added in the preparation of prepared animal feeds. Corn, wheat and soybean processors were assumed to be operating at full capacity in 1976. Food and feed product production for the years 1969-75 was derived by applying the growth rates of corn, wheat, and soybean disappearance for food and feed use on a national level to the BEA segment 1976 production, working the trend in reverse.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Processing capacity by BEA and BEA segment for 1976 from Grains (Group V) Report. Food and feed use national level growth rates derived from U.S. Department of Agriculture, Agricultural Statistics, 1977 ed. Corn yields from U.S. Department or Commerce, Bureau of the Census, Census of Manufactures, 1972 ed.

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Table B-10. Ohio River Basin: Production of Wood and Paper Products,[a] by BEA or BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	4,833.1	4,945.2	5,048.2	5,340.0	5,469.2	5,842.0	5,490.7	5,788.4
BEA 47: Huntsville, AL	1,864.0	1,900.1	1,931.5	2,048.0	2,101.9	2,161.0	2,068.0	2,196.4
BEA 48: Chattanooga, TN	1,547.8	1,578.5	1,595.7	1,682.5	1,732.4	1,856.9	1,679.0	1,822.1
BEA 50: Knoxville, TN	620.0	644.8	675.5	731.6	740.8	844.2	798.1	814.7
BEA 54: Louisville, KY	333.2	337.8	342.5	347.4	352.3	414.3	362.4	367.5
BEA 62: Cincinnati, OH	162.1	168.3	178.3	194.5	192.2	215.6	215.3	208.3
BEA 66: Pittsburgh, PA	199.4	202.6	206.2	210.5	213.0	250.2	221.9	223.0
BEA 115: Paducah, KY	106.6	113.1	118.5	125.5	136.6	99.8	146.0	156.4

a. Wood and paper products include lumber products, pulpwood logs and paper products.
b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.
Source: Tables 13, 14, and 15 of Group X Report.

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Table B-11. United States and Ohio River Basin: Production of Petroleum Products, Nec., by BEAs or BEA Segments[a], Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	46,079.2	48,048.4	49,555.4	50,118.0	53,047.2	53,471.7	45,697.4	49,870.2
Primary Study Areas	980.9	984.9	1,050.7	1,028.1	1,092.1	1,102.2	988.8	1,026.9
BEA 47: Huntsville, AL	--	--	--	--	--	--	--	--
BEA 48: Chattanooga, TN	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	--	--	--	--	--	--	--	--
BEA 50: Knoxville, TN	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV	555.6	565.3	607.6	587.9	622.5	627.4	558.3	576.3
BEA 54: Louisville, KY	90.3	92.1	99.5	96.6	101.8	102.0	90.1	92.3
BEA 62: Cincinnati, OH	162.7	163.6	173.7	170.8	180.3	180.2	158.1	164.5
BEA 64: Columbus, OH	79.1	72.1	71.9	72.8	78.6	81.2	76.5	81.2
BEA 66: Pittsburgh, PA	93.2	91.8	98.0	100.0	108.9	111.4	105.8	112.6
BEA 68: Cleveland, OH	--	--	--	--	--	--	--	--
BEA 115: Paducah, KY	--	--	--	--	--	--	--	--

Note: Petroleum products include lubricating oils and greases, naphthas, and asphalt. Production of naphthas by BEA segments based on the ratio of naphtha production to gasoline production and the production of gasoline by BEA segments. Production of gasoline by BEA segments based on state motor gasoline figures distributed among BEA segments on the basis of the 1969-76 distribution of state gasoline capacity of operating plants among BEA segments. Annual distribution was estimated as the average of distributions obtained for January 1 of each year and the following year. 1969 distribution of capacity assumed equal to January 1, 1970 distribution. Production of asphalt by BEA segments based on the ratio of Petroleum Administration for Defense district asphalt production to district asphalt capacity multiplied by asphalt capacity by BEA segments. This capacity was estimated from the crude petroleum operating capacity for refineries producing asphalt locating in each BEA. Distribution of capacity assumed equal to 1972 distribution. Lubricant production was estimated using the same procedure.

a. Segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Interior, Bureau of Mines, "Crude Petroleum and Petroleum Products," Minerals Yearbook, 1969-76 eds., and Mineral Industry Surveys: Petroleum Refineries in the United States and Puerto Rico, January 1, 1970-76 eds.

Table B-12. United States and Ohio River Basin: Production of Portland Cement and Lime, by BEAs or BEA Segments[a], Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	95,400.0	91,200.0	98,500.0	103,000.0	106,100.0	102,500.0	87,800.0	92,800.0
Primary Study Areas	4,048.0	3,607.0	3,979.0	4,232.0	4,491.0	4,400.0	3,794.0	4,215.0
BEA 47: Huntsville, AL	191.0	185.0	186.0	197.0	182.0	179.0	138.0	148.0
BEA 49: Nashville, TN	191.0	185.0	186.0	197.0	182.0	179.0	138.0	148.0
BEA 50: Knoxville, TN	591.0	575.0	582.0	612.0	566.0	554.0	427.0	457.0
BEA 52: Huntington, WV	368.0	298.0	375.0	385.0	415.0	389.0	306.0	292.0
BEA 54: Louisville, KY	799.0	698.0	738.0	769.0	853.0	801.0	688.0	758.0
BEA 62: Cincinatti, OH	.0	.0	83.0	167.0	250.0	333.0	417.0	500.0
BEA 66: Pittsburgh, PA	1,278.0	1,140.0	1,257.0	1,323.0	1,465.0	1,364.0	1,120.0	1,213.0
BEA 115: Paducah, KY	630.0	526.0	572.0	582.0	578.0	601.0	560.0	699.0

Note: Estimates of annual state production of lime and portland cement were obtained from Minerals Yearbook. Production of portland cement allocated to BEAs and BEA segments according to the distribution of production capacity. Production of limestone allocated to BEAs and BEA segments from capacity estimates of larger plants obtained from industry experts and from number of small plants located in each BEA and BEA segment obtained from Bureau of Mines.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Area Reports: Domestic, Vol. II of Minerals Yearbook, 1969-76 eds.; Portland Cement Association, Portland Cement Plants by Producing Capacity, December 31, 1975 and unpublished data provided by the Bureau of Mines and other industry experts.

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Table B-13. Ohio River Basin: Production of Nonferrous Metals and Alloys,[a] by BEAs or BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	1,827.8	1,801.7	1,772.1	1,883.5	2,049.2	2,594.7	2,215.1	2,771.2
BEA 48: Chattanooga, TN	89.0	86.3	84.3	96.7	105.0	156.9	165.0	225.1
BEA 49: Nashville, TN	145.6	146.8	147.0	159.4	176.0	208.4	177.7	215.3
BEA 50: Knoxville, TN	242.8	254.5	251.2	263.8	289.9	548.7	422.6	500.8
BEA 52: Huntington, WV	184.2	185.4	188.4	206.6	234.3	281.1	244.9	330.8
BEA 55: Evansville, IN	463.2	471.8	468.2	503.2	549.1	649.6	569.8	717.0
BEA 62: Cincinnati, OH	49.9	46.9	49.7	57.4	67.5	79.9	72.2	99.2
BEA 66: Pittsburgh, PA	653.1	610.0	583.3	596.4	627.4	670.1	562.9	683.0

Note: Production by BEAs and BEA segments of each nonferrous metal was calculated from its total U.S. production, based on the employment distribution ratios obtained by dividing the number of employees of a particular metal industry in each BEA segment by the total U.S. employment of that industry.

a. Includes the primary metal of aluminum, copper, lead, zinc, nickel, titanium, magnesium, tin, antimony, manganese, and cadmium, and primary products of aluminum, copper, and molybdenum.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, 1972-78; U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures, 1976; American Metal Market, Metal Statistics, 1971-78; The Aluminum Association, Aluminum Statistical Review, 1977 ed.; U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1973, 1974, 1976 eds.

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Table B-14. Ohio River Basin: Production of Selected Manufactured Products,[a] by BEAs or BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	7,163.4	7,150.3	6,553.6	6,965.7	7,533.8	8,023.0	7,214.7	7,449.0
BEA 47: Huntsville, AL	85.0	88.7	85.8	93.9	100.9	114.5	102.4	109.5
BEA 48: Chattanooga, TN	348.5	342.6	331.2	355.1	395.9	439.4	363.5	381.1
BEA 49: Nashville, TN	462.1	467.0	436.5	482.2	531.9	585.9	483.9	507.0
BEA 50: Knoxville, TN	97.3	103.1	96.6	104.6	118.4	137.1	113.5	119.5
BEA 52: Huntington, WV	421.0	439.4	395.0	438.4	485.2	511.3	540.7	570.0
BEA 54: Louisville, KY	1,243.7	1,272.9	1,156.1	1,302.3	1,412.9	1,505.6	1,237.1	1,319.4
BEA 55: Evansville, IN	438.3	442.3	401.0	437.8	472.0	500.2	406.5	431.0
BEA 62: Cincinnati, OH	1,417.3	1,345.5	1,259.6	1,273.3	1,363.6	1,438.5	1,275.6	1,305.1
BEA 64: Columbus, OH	359.5	363.7	309.7	346.2	377.7	388.6	393.8	411.9
BEA 65: Clarksburg, WV	178.1	187.8	182.8	195.7	217.5	230.4	250.0	266.1
BEA 66: Pittsburgh, PA	2,071.3	2,055.2	1,861.5	1,892.2	2,010.6	2,122.2	2,008.8	1,987.6
BEA 115: Paducah, KY	41.3	42.1	37.8	44.0	47.2	49.3	38.9	40.8

Note: Production excludes shipments of selected manufactured goods consumed within 25 miles of plant where produced, shipments moved by parcel post and commodities moved by own power. Production of fabricated machinery products, machinery products, and electrical machinery products by state was obtained for 1972 from Census of Transportation. Production of each of these product groups was distributed to BEAs and BEA segments on basis of employment. Annual changes in employment in each of these industries by state, applied to appropriate state portions of BEAs and BEA segments, were the basis for estimating annual levels of production.

a. Includes fabricated metal products, machinery products, electrical machinery products, and ships and boats.

b. BEA segments defined as the counties which are ultimate origins or destinations of waterborne movements

Source: Estimated from U.S. Department of Commerce, Bureau of the Census, Census of Transportation, 1972 ed., and County Business Patterns, 1969-76 eds.

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Table B-15. Ohio River Basin: Production of Others, Nec., by Commodity Types and BEAs or BEA Segments[a], 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	16,041.4	15,493.6	14,190.2	15,362.0	17,698.1	19,001.5	15,471.6	15,273.5
Petro, coal products	2,602.8	2,406.6	2,230.1	2,397.5	2,637.6	2,632.7	2,269.0	2,198.6
Slag, iron and steel	11,100.5	10,220.6	9,479.6	10,576.6	11,789.5	11,472.2	8,802.4	9,424.9
Waterway improvement materials	2,338.1	2,866.4	2,480.5	2,387.9	3,271.0	4,896.6	4,400.2	3,650.0
BEA 47: Huntsville, AL	--	--	0.6	--	0.1	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	0.6	--	0.1	--	--	--
BEA 49: Nashville, TN	1.7	2.1	3.9	1.2	--	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	1.7	2.1	3.9	1.2	--	--	--	--
BEA 52: Huntington, WV	1,413.7	1,362.6	1,346.3	1,371.5	1,615.0	1,484.6	1,139.2	1,295.5
Petro, coal products	311.2	299.3	298.1	289.6	337.1	328.5	274.7	318.9
Slag, iron and steel	1,100.6	1,059.0	1,048.2	1,081.9	1,252.0	1,155.8	864.4	976.6
Waterway improvement materials	1.9	4.3	--	--	25.9	0.3	0.1	--
BEA 54: Louisville, KY	151.7	215.9	157.3	236.5	324.2	170.8	173.0	16.6
Petro, coal products	8.1	7.4	7.7	7.4	8.3	9.8	12.4	16.0
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	143.6	208.5	149.6	229.1	315.9	161.0	160.6	0.6
BEA 55: Evansville, IN	49.0	87.6	91.8	124.2	73.7	36.0	17.2	22.5
Petro, coal products	5.7	3.7	3.7	3.8	4.7	5.8	8.1	12.2
Slag, iron and steel	11.4	11.2	11.1	12.3	11.3	12.2	9.1	10.3
Waterway improvement materials	31.9	72.7	77.0	108.1	55.7	18.0	--	--
BEA 62: Cincinnati, OH	1,844.8	1,580.1	1,364.0	1,467.6	1,668.3	1,458.0	1,096.9	1,237.5
Petro, coal products	268.4	256.8	252.1	270.0	287.2	273.5	212.5	238.3
Slag, iron and steel	1,125.8	1,087.2	1,074.3	1,187.2	1,282.2	1,183.0	884.4	999.2
Waterway improvement materials	450.6	236.1	37.6	10.4	98.9	1.5	--	--

(Continued)

Table B-15. (Continued)

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BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
BEA 64: Columbus, OH	13.7	149.9	1.5	2.1	77.9	20.5	20.6	2.9
Petro, coal products	1.7	1.4	1.5	1.5	1.3	1.8	2.1	2.9
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	12.0	148.5	--	0.6	76.6	18.7	18.5	--
BEA 66: Pittsburgh, PA	11,079.8	9,958.9	9,051.9	10,128.4	11,281.9	11,144.9	8,817.1	9,053.9
Petro, coal products	2,007.7	1,838.0	1,667.0	1,825.2	1,999.0	2,013.3	1,759.2	1,610.3
Slag, iron and steel	8,862.7	8,063.2	7,346.0	8,295.2	9,242.0	9,121.2	7,044.5	7,438.8
Waterway improvement materials	209.4	57.7	38.9	8.0	40.9	10.4	13.4	4.8
BEA 115: Paducah, KY	1,487.0	2,136.5	2,172.9	2,030.5	2,657.0	4,686.7	4,207.6	3,644.6
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	1,487.0	2,136.5	2,172.9	2,030.5	2,657.0	4,686.7	4,207.6	3,644.6

Note: Petroleum and coal products, nec., consist of petroleum products and coal products. Petroleum products include wax and miscellaneous petroleum products, and coal products include coke oven gas, tar, crude light oil and coke oven ammonia. Slags include iron slags and steel slags. Waterway improvement materials primarily include rip-rap limestone produced to meet the specific needs of the U.S. Army Corps of Engineers.

Production of petroleum products, nec., was computed by multiplying the average tons of petroleum products produced per ton of crude oil consumed in the U.S. by the estimated crude oil consumption in the BEAs provided in Commodity Group III Report (Crude Petroleum). Production of coal products was computed from the coal consumed in coke plants in the BEAs, based on the estimates that a ton of coal consumed would yield 0.123 ton of coal products which are not consumed in the producing plants themselves.

Production of iron slags was estimated by applying a factor of 0.3125 tons of slag produced in blast furnaces per ton of pig iron produced to the RRNA estimates of pig iron production by BEA provided in Commodity Group VIII report (Iron ore, Iron and Steel). Production of steel slags is computed by applying the ratios of 250 lbs. of slag per ton of steel produced by open hearth and basic oxygen furnances, and 150 lbs. of slag per ton of steel produced by electric arc furnaces to the BEA's iron and steel production estimates in Group VIII report.

Production of waterway improvement materials was estimated assuming all waterway improvement materials are shipped by barges, i.e. the origin shipments of a BEA equal the total waterway improvement materials produced in that BEA for any particular years.

a. Segments defined as counties which are ultimate origins or destinations of waterway improvements.

Source: Drake, H.J. and J.E. Shelton, "Disposal of Iron and Steel Slag," Proceedings of the Fourth Mineral Waste Utilization Symposium, Chicago, IL., May 1974; U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1975 ed., pp. 505-07; Coal, Crude Petroleum and Iron Ore, Iron and Steel Reports; and Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

APPENDIX C

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Table C-1. Ohio River System: Coal Consumption by BEAs or BEA Segments[a] and by End User, Estimated 1969-76

(Thousands of tons unless otherwise specified)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change
Primary Study Areas	127,181.1	137,126.7	143,556.2	157,930.0	171,470.9	171,251.9	192,960.5	194,578.4	6.26
Electric utilities	96,169.7	106,483.9	114,180.6	126,008.8	136,603.1	136,420.6	159,546.8	161,953.2	7.73
Coke plants	21,033.8	19,592.9	18,088.2	19,396.3	21,359.2	21,203.6	17,952.4	16,880.1	(3.09)
Others	9,977.6	11,049.9	11,287.4	12,524.9	13,508.6	13,627.7	15,461.3	15,745.1	6.73
BEA 47: Huntsville, AL	3,813.5	3,604.4	3,144.1	2,673.9	3,248.9	3,294.9	3,088.6	3,356.6	(1.81)
Electric utilities	3,614.7	3,416.5	2,980.2	2,534.5	3,079.5	3,123.1	2,927.6	3,181.6	(1.81)
Coke plants	--	--	--	--	--	--	--	--	--
Others	198.8	187.9	163.9	139.4	169.4	171.8	161.0	175.0	(1.81)
BEA 48: Chattanooga, TN	4,750.1	4,628.9	4,931.4	4,560.5	4,337.1	4,819.7	5,976.2	5,511.9	2.15
Electric utilities	4,243.8	4,144.0	4,434.7	4,072.5	3,852.2	4,303.1	5,411.1	4,972.4	2.29
Coke plants	154.4	142.0	131.4	150.2	163.6	159.6	122.4	131.2	(2.30)
Others	351.9	342.9	365.3	337.8	321.3	357.0	442.7	408.3	2.15
BEA 49: Nashville, TN	7,358.4	7,235.0	6,621.2	6,028.2	7,811.7	11,644.6	13,748.9	11,102.3	6.05
Electric utilities	6,813.3	6,699.1	6,130.7	5,581.7	7,233.1	10,774.6	12,730.9	10,279.9	6.05
Coke plants	--	--	--	--	--	--	--	--	--
Others	545.1	535.9	490.5	446.5	578.6	870.0	1,018.0	822.4	6.05
BEA 50: Knoxville, TN	6,333.9	6,414.1	6,734.6	6,939.8	7,548.8	7,027.9	8,688.2	7,476.9	2.40
Electric utilities	5,864.7	5,939.0	6,235.7	6,425.7	6,989.6	6,507.3	8,047.6	6,923.1	2.40
Coke plants	--	--	--	--	--	--	--	--	--
Others	469.2	475.1	498.9	514.1	559.2	520.6	640.6	553.8	2.40
BEA 51: Bristol, VA	4,757.1	4,458.1	4,521.4	4,562.4	5,014.1	4,306.7	5,127.4	5,132.4	1.09
Electric utilities	3,977.2	3,624.4	3,723.7	3,829.9	4,165.3	3,513.2	4,322.9	4,383.5	1.40
Coke plants	347.4	428.4	386.7	317.7	393.0	402.0	338.4	282.3	(2.92)
Others	432.5	405.3	411.0	414.8	455.8	391.5	466.1	466.6	1.09)
BEA 52: Huntington, WV	10,351.9	13,062.6	14,726.1	17,380.0	20,538.9	26,963.2	30,773.4	34,708.9	18.87
Electric utilities	7,204.0	9,719.2	11,291.2	13,731.8	16,268.1	22,251.4	26,257.5	29,683.4	22.42
Coke plants	3,183.3	2,112.6	2,080.5	2,016.9	2,366.9	2,229.5	1,673.6	1,828.3	(2.41)
Others	964.6	1,230.8	1,354.4	1,631.3	1,903.9	2,482.3	2,842.3	3,197.2	18.67

(Continued)

Table C-1. (Continued)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change
BEA 53: Lexington, KY	1,353.5	1,827.8	2,447.5	2,714.5	3,163.0	2,600.9	2,973.4	2,909.3	11.55
Electric utilities	1,241.7	1,676.9	2,245.4	2,490.4	2,901.8	2,386.1	2,727.9	2,669.1	11.55
Coke plants	--	--	--	--	--	--	--	--	--
Others	111.8	150.9	202.1	224.1	261.2	214.8	245.5	240.2	11.55
BEA 54: Louisville, KY	9,996.2	9,303.3	9,603.3	9,639.9	9,832.8	8,549.1	10,882.6	11,134.9	1.55
Electric utilities	9,170.8	8,535.1	8,810.4	8,843.9	9,020.9	7,843.2	9,984.0	10,215.5	1.55
Coke plants	--	--	--	--	--	--	--	--	--
Others	825.4	768.2	792.9	796.0	811.9	705.9	898.6	919.4	1.55
BEA 55: Evansville, IN	7,491.1	11,550.5	13,093.0	13,916.7	14,075.2	13,163.2	19,492.3	17,665.4	13.04
Electric utilities	6,872.6	10,596.8	12,011.9	12,767.6	12,913.0	12,076.3	17,882.8	16,206.8	13.04
Coke plants	--	--	--	--	--	--	--	--	--
Others	618.5	953.7	1,081.1	1,149.1	1,162.2	1,086.9	1,609.5	1,458.6	13.04
BEA 62: Cincinnati, OH	9,189.4	10,025.9	9,222.8	13,982.6	14,949.8	15,585.7	17,994.9	20,981.0	12.52
Electric utilities	6,127.8	6,798.8	6,254.1	10,343.9	11,108.5	11,783.9	14,439.0	16,957.9	15.65
Coke plants	2,045.5	1,983.9	1,954.5	2,094.2	2,221.2	2,090.6	1,568.0	1,718.7	(2.46)
Others	1,016.1	1,243.2	1,014.2	1,544.5	1,620.1	1,711.2	1,987.9	2,304.4	12.41
BEA 64: Columbus, OH	7,049.4	7,234.2	7,681.5	7,127.3	7,077.2	6,695.8	5,751.1	6,347.4	(1.49)
Electric utilities	6,294.1	6,459.1	6,858.5	6,363.6	6,318.9	5,889.1	5,139.4	5,667.3	(1.49)
Coke plants	--	--	--	--	--	--	--	--	--
Others	755.3	775.1	823.0	763.7	758.3	706.7	611.7	680.1	(1.49)
BEA 65: Clarksburg, WV	5,187.6	4,918.2	4,658.5	4,788.4	4,864.9	3,612.6	4,548.7	5,321.5	0.36
Electric utilities	4,716.0	4,471.1	4,235.0	4,353.1	4,422.6	3,284.2	4,135.2	4,837.7	0.36
Coke plants	--	--	--	--	--	--	--	--	--
Others	471.6	447.1	435.5	435.3	443.3	328.4	413.5	483.8	0.36
BEA 66: Pittsburgh, PA	41,047.2	44,255.3	47,790.8	55,336.5	60,443.5	54,759.7	54,787.7	54,717.3	4.19
Electric utilities	22,046.1	26,320.9	31,100.6	36,896.2	40,290.2	34,865.5	36,970.9	38,170.3	8.16
Coke plants	16,303.2	14,926.0	13,535.1	14,817.3	16,214.5	16,321.9	14,250.0	13,019.0	(3.16)
Others	2,697.9	3,008.4	3,155.1	3,623.0	3,938.8	3,572.3	3,566.8	3,528.0	3.91

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Table C-1. (Continued)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change
BEA 68: Cleveland, OH	--	--	--	--	--	--	--	--	--
Electric utilities	--	--	--	--	--	--	--	--	--
Coke plants	--	--	--	--	--	--	--	--	--
Others	--	--	--	--	--	--	--	--	--
BEA 115: Paducah, KY	8,501.8	8,608.4	8,380.0	8,279.3	8,565.0	8,327.9	9,127.1	8,312.0	(0.32)
Electric utilities	7,982.9	9,083.0	7,868.5	7,774.0	8,039.4	7,819.6	8,570.0	7,804.7	(0.32)
Coke plants	--	--	--	--	--	--	--	--	--
Others	518.9	525.4	511.5	505.3	525.6	508.3	557.1	507.3	(0.32)

Note: Electric utility plant consumption of coal was estimated by aggregating the individual plants' consumption of coal into the proper BEA. This quantity was increased five percent to reflect those plants which are not required to report to the FPC or FERC.

Coke plant consumption of coal was estimated for BEAs 52, 62, and 66, by using the pig iron production estimates for these BEAs contained in the Iron Ore, Steel and Iron Report. The amount of coal necessary to produce the coke needed for these production levels was calculated using a factor of 0.7 tons of coke per ton of coal carbonized, and the historical factor of tons of coke consumed per ton of pig iron produced as reported in the Annual Statistical Report of the American Iron and Steel Institute. Coal consumption for coke plants in other BEAs, which are merchant coke plants, was estimated by multiplying steel industry capacity utilization rates by the coke plant capacity rates of coal usage to determine the coal consumed.

Other usage of coal was estimated from factors estimated by RRNA based on DOE data. These factors were applied to electric utilities coke plant consumption of coal to approximate residual usage of coal.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Energy, Federal Energy Regulatory Commission and Federal Power Commission, Annual Summary of Cost and Quality of Electric Utility Plant Fuel, 1975-77 eds.; and Steam Electric Plant Construction Cost and Annual Production Expenses, 1969-74 eds.; U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1969-75 eds.; U.S. Department of Energy, Bituminous Coal and Lignite Distribution, 1971-76 eds.; U.S. Department of Energy, Coke and Coal Chemicals, 1976 ed.; U.S. Department of the Interior, Bureau of Mines, Coke Producers in the United States, 1976 ed.; American Iron and Steel Institute, Annual Statistical Report, 1976 ed.; and Keystone Coal Industry Manual, 1978 ed.

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Table C-2. United States and Ohio River Basin: Consumption of Petroleum Fuels, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	616,597.1	645,299.7	670,395.8	726,090.5	764,666.4	725,853.7	717,590.9	774,818.9
Primary Study Areas	36,518.8	38,201.1	38,981.7	42,488.1	44,197.8	43,670.2	43,254.5	47,592.3
BEA 47: Huntsville, AL	1,416.5	1,504.3	1,555.4	1,752.1	1,954.4	1,955.0	2,007.3	2,276.5
BEA 48: Chattanooga, TN	1,636.8	1,708.6	1,812.9	2,018.6	2,284.4	2,198.5	2,202.1	2,420.1
BEA 49: Nashville, TN	2,974.7	3,083.0	3,217.4	3,553.2	3,955.9	3,887.3	4,100.5	4,529.6
BEA 50: Knoxville, TN	1,913.8	1,972.5	2,075.0	2,276.0	2,528.4	2,466.4	2,590.9	2,867.7
BEA 52: Huntington, WV	2,491.8	2,611.7	2,631.9	2,930.3	3,045.1	3,098.6	3,216.0	3,517.5
BEA 53: Lexington, KY	1,615.5	1,675.7	1,692.4	1,842.1	1,956.8	1,963.5	2,007.5	2,204.2
BEA 54: Louisville, KY	2,930.0	2,998.7	3,032.7	3,265.7	3,425.4	3,410.5	3,418.9	3,662.5
BEA 55: Evansville, IN	2,050.8	2,102.1	2,192.4	2,376.2	2,425.9	2,348.5	2,313.5	2,485.9
BEA 62: Cincinnati, OH	4,105.2	4,218.8	4,272.4	4,641.5	4,814.3	4,733.6	4,778.1	5,210.0
BEA 64: Columbus, OH	3,504.5	3,617.3	3,647.2	4,042.0	4,158.8	4,054.3	4,213.9	4,634.4
BEA 65: Clarksburg, WV	448.3	475.6	477.5	539.0	562.3	565.2	586.3	629.1
BEA 66: Pittsburgh, PA	10,688.9	11,433.8	11,528.5	12,325.2	12,137.4	11,999.1	10,859.2	12,118.4
BEA 68: Cleveland, OH	261.3	264.5	267.8	292.4	304.0	294.5	305.4	336.8
BEA 115: Paducah, KY	480.7	534.5	578.2	633.8	644.7	655.2	654.4	699.6

Note: State consumption data for petroleum fuels were obtained by major use from the Bureau of Mines and the Department of Energy. Fuels consumed in household, commercial, and transportation uses were distributed among BEAs and BEA segments on the basis of population distribution. Fuels consumed in industrial uses were distributed among BEAs and BEA segments on the basis of manufacturing employment, except for liquefied petroleum gases used in the manufacture of chemicals, which were distributed on the basis of 1970 distribution of chemical employment. Fuels used in miscellaneous uses were distributed among BEAs and BEA segments on the basis of other petroleum fuel distribution.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. and state consumption from U.S. Department of the Interior, Bureau of Mines, Historical Fuels and Energy Consumption Data, 1960-72, United States and Census Districts East of the Mississippi; Fuels and Energy Data: United States by States and Census Divisions, 1973, 1974; "Crude Petroleum and Petroleum Products," Minerals Yearbook, 1976 ed.; and from U.S. Department of Energy, "Sales of Fuel Oil and Kerosine in 1976" and "Sales of Liquefied Petroleum Gases and Ethane in 1976," Energy Data Reports. Population and manufacturing employment data provided by the U.S. Department of Commerce, Bureau of Economic Analysis, and from the U.S. Bureau of Labor Statistics, Employment and Earnings, United States 1966-75.

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Table C-3. United States and Ohio River Basin: Consumption of Crude Petroleum, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	578,002.0	591,601.0	608,784.0	639,998.0	683,060.0	667,698.0	686,203.0	745,671.0
Primary Study Areas	1,370.7	1,210.6	1,252.5	1,403.9	1,589.3	1,602.5	1,707.9	1,880.2
BEA 55: Evansville, IN	803.4	620.7	624.3	671.5	707.9	700.3	831.8	953.5
BEA 64: Columbus, OH	235.2	238.5	252.0	263.0	191.3	214.4	212.3	225.1
BEA 66: Pittsburgh, PA	332.1	351.4	376.2	469.4	690.1	687.8	663.8	701.6

Note: Consumption by BEAs and BEA segments is based on state refinery consumption figures distributed among BEA regions on the basis of the 1969-76 distribution of state petroleum refinery capacity of operating plants among BEAs and BEA segments. Annual distribution was estimated as the average of distributions obtained for January 1 of each year and the following year. In 1969 distribution of capacity was assumed equal to January 1, 1970 distribution.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, "Crude Petroleum and Petroleum Products," Minerals Yearbook, 1969-76 eds., and "Petroleum Refineries in the United States and Puerto Rico," Mineral Industry Surveys, January 1, 1970-76.

Table C-4. Ohio River Basin: Consumption of Aggregates, by BEA or BEA Segments, Estimated 1969-76

(Thousands of tons)

BEA or BEA Segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Area	122,292.2	116,350.8	119,068.4	126,646.8	152,898.0	137,926.3	127,829.3	132,319.2
BEA 47: Huntsville, AL	4,868.8	4,692.0	4,490.2	4,746.6	5,522.6	6,200.2	5,506.4	6,021.4
BEA 48: Chattanooga, TN	8,355.6	7,466.0	6,879.0	7,852.8	11,211.8	9,127.2	9,841.6	7,992.6
BEA 49: Nashville, TN	13,677.8	14,414.0	13,993.8	15,955.6	18,898.6	17,982.2	17,195.4	20,777.4
BEA 50: Knoxville, TN	7,178.3	7,622.3	7,395.1	8,455.0	9,757.1	9,361.0	8,858.1	8,852.9
BEA 52: Huntington, WV	8,489.4	7,918.5	9,246.3	9,305.4	10,968.0	10,246.0	9,804.3	9,286.1
BEA 53: Lexington, KY	6,264.0	6,061.0	5,160.0	6,542.0	7,691.0	6,903.0	6,557.0	6,861.0
BEA 54: Louisville, KY	14,569.2	13,863.4	14,118.4	14,760.2	18,354.4	15,350.8	14,181.4	14,874.4
BEA 55: Evansville, IN	6,915.9	6,608.8	6,799.9	7,109.8	9,970.8	7,472.5	6,778.7	7,140.8
BEA 62: Cincinnati, OH	17,297.0	15,581.3	15,615.2	16,573.6	19,561.7	17,006.2	15,649.1	15,897.2
BEA 64: Columbus, OH	2,447.0	2,253.0	2,411.0	2,494.0	2,913.0	2,612.0	2,448.0	2,550.0
BEA 65: Clarksburg, WV	1,278.0	1,263.0	1,663.0	1,629.0	2,010.0	1,943.0	1,943.0	1,743.0
BEA 66: Pittsburgh, PA	26,087.2	24,141.7	25,573.9	26,402.2	30,597.6	28,660.4	24,289.3	25,508.2
BEA 68: Cleveland, OH	1,416.0	1,273.0	1,366.0	1,415.0	1,661.0	1,503.0	1,404.0	1,346.0
BEA 115: Paducah, KY	3,448.0	3,192.8	3,356.6	3,405.6	3,780.4	3,558.8	3,373.0	3,688.2

Note: Total state consumption of aggregates by state was assumed equal to state production of sand, gravel and crushed rock, plus consumption of specified material used in the construction of nuclear plants. State production data were obtained from Mineral Yearbook and available estimates of aggregates produced and consumed on site, which were excluded from Bureau of Mines data. Aggregates used for construction purposes were estimated at a state level by subtraction of industrially used aggregates from state consumption totals. Aggregates used in construction (other than nuclear plant construction) were distributed to BEA segments on the basis of population. Aggregates used in nuclear plant construction were estimated by BEA segment from Construction Status Report; Capital and Cost; Boiling Water Reactor Plants; Capital Cost: Pressurized Water Reactor Plant. Characteristics of consumption for ORB nuclear plants assumed to be the same as for the typical plants described in those sources. This consumption was assumed to occur in first 10 percent of construction period. Estimates of industrial consumption of aggregates by state and by BEA segment were obtained from Mineral Yearbook and from estimates of consumption in the manufacture of steel, lime and cement. Production of steel, lime and cement were obtained from RRNA estimates of these commodities (Groups VIII and XII). The aggregates requirements for this production were obtained from American Iron and Steel Institute, Annual Statistical Report, and the Bureau of Mines.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Estimated by RRNA from U.S. Department of the Interior, Bureau of Mines, Area Reports, Vol. II of Minerals Yearbook, 1969-76 eds.; U.S. Department of Energy, Energy Information Agency, Nuclear Analysis Division, Construction Status Report, November 30, 1978 and Nuclear Regulatory Commission, Capital Cost: Boiling Water Reactor Plants and Capital Cost: Pressurized Water Reactor Plant. Population data supplied by U.S. Department of Commerce, Bureau of Economic Analysis. Conversion factors for industrial consumption from American Iron and Steel Institute, Annual Statistical Report, 1969-76, and U.S. Department of the Interior, Bureau of Mines, Mineral Facts and Problems, 1975, and unpublished information from the Bureau of Mines. Cement and lime and iron and steel production estimates from Group XII and Group VIII sections of this study.

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Table C-5. Ohio River Basin: Consumption of Grains,[a] by BEAs or BEA Segments,[b] 1969-76

(Thousand of tons unless otherwise specified)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Primary Study Areas	23,459.3	24,706.7	3,906.1	23,216.7	23,315.5	22,287.7	21,950.6	22,081.5	(0.86)
BEA 44: Atlanta, GA	1,667.8	1,673.4	1,621.7	1,625.3	1,544.0	1,559.9	1,532.4	1,577.8	(0.79)
BEA 45: Birmingham, AL	1,295.8	1,311.7	1,319.6	1,323.8	1,258.5	1,214.8	1,218.8	1,272.9	(0.25)
BEA 46: Memphis, TN	385.4	385.1	433.8	368.7	370.0	386.4	373.3	310.9	(3.02)
BEA 47: Huntsville, AL	1,91[illegible]4	1,992.1	2,038.1	2,054.8	2,003.9	2,000.8	2,050.2	2,059.8	1.07
BEA 48: Chattanooga, TN	1,840.1	1,861.6	1,915.5	1,909.5	1,849.3	1,813.5	1,797.7	1,823.0	(0.13)
BEA 49: Nashville, TN	2,601.3	2,781.2	2,632.8	2,502.7	2,519.5	2,353.2	2,404.6	2,270.6	(1.92)
BEA 50: Knoxville, TN	342.0	338.6	357.2	371.6	334.6	329.5	343.0	326.7	(0.65)
BEA 52: Huntington, WV	320.3	326.2	309.6	285.1	308.0	266.0	271.6	256.2	(3.14)
BEA 53: Lexington, KY	1,230.4	1,437.6	1,278.0	1,188.1	1,196.8	1,168.4	1,198.3	1,177.8	(0.62)
BEA 54: Louisville, KY	1,910.6	2,071.7	1,892.4	1,837.2	1,865.4	1,783.8	1,752.9	1,778.6	(1.02)
BEA 55: Evansville, IN	2,782.1	3,054.8	2,828.4	2,744.5	2,740.2	2,617.1	2,472.8	2,550.5	(1.23)
BEA 56: Terre Haute, IN	100.8	112.6	103.7	88.3	92.4	88.6	73.6	83.4	(2.67)
BEA 60: Indianapolis, IN	1,804.2	1,893.0	1,845.3	1,784.3	1,791.2	1,763.4	1,639.3	1,760.8	(0.35)
BEA 61: Anderson, IN	189.3	188.3	193.1	161.8	178.0	167.9	164.7	164.8	(1.96)
BEA 62: Cincinnati, Oh	1,298.2	1,374.4	1,325.4	1,276.3	1,399.6	1,187.9	1,168.7	1,202.3	(1.09)
BEA 63: Dayton, OH	1,645.8	1,678.1	1,683.2	1,669.3	1,758.0	1,692.5	1,615.0	1,602.7	(0.38)
BEA 64: Columbus, OH	638.9	650.4	644.5	609.8	695.7	559.8	561.1	539.1	(2.40)
BEA 114: St. Louis, MO	204.1	214.2	225.9	217.4	218.0	208.4	205.2	205.2	0.08
BEA 115: Paducah, KY	1,290.9	1,361.7	1,258.0	1,197.2	1,192.6	1,125.8	1,107.4	1,118.3	(2.03)

Note: Individual items may not add to total due to rounding. Data assembled on a county level and aggregated into BEAs and BEA segments.

a. Total consumption of corn, wheat and soybeans. Corn is corn for grain. Wheat is all wheat. Soybeans are soybeans for beans. Consumption of grains represents the addition of the consumption of corn, wheat and soybeans by livestock, seed and processing.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Livestock consumption was estimated by taking the number of livestock by county for 11 categories of livestock (milk cows, cattle on feed, other cattle, hogs and pigs, sheep and lambs, hens and pullets, other chickens, broilers, turkeys, and horses and mules) and multiplying by an annual ration provided by the U.S. Department of Agriculture Crop Reporting Services for each grain (corn, wheat and soya) for each of the eight states (Alabama, Georgia, Illinois, Indiana, Kentucky, Mississippi, Ohio and Tennessee). The rations were assumed to remain constant

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Table C-5. (Continued)

over the eight-year period. The livestock numbers were taken, to the extent possible, from data provided annually by the U.S. Department of Agriculture Crop Reporting Services for each of the eight states. Where only state totals were available, these were distributed on a county level based on the county distribution of the 11 livestock categories as provided by the U.S. Department of Agriculture, Census of Agriculture, 1974. Consumption of grains by processors was estimated by utilizing lists of grain processors by type of grain, capacity, and city and state location. These lists were provided by commodity experts. Processors were assigned to their appropriate county and BEA and BEA segment and assumed to be operating at capacity. Consumption of grains for seed was estimated by multiplying the BEA and BEA segment acres harvested for each grain by the crop seeding rate as provided for state and year in the U.S. Department of Agriculture, Agricultural Statistics (various years). A factor was included in the multiplication to reflect the difference between acres harvested and acres planted. Seeding rates were weighted for BEAs and BEA segments in two or more states, e.g., BEA 55.

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Table C-6. Ohio River Basin: Consumption of Industrial Chemicals and Agricultural Chemicals, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons unless otherwise specified)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Primary Study Areas	8,672.1	9,705.1	10,501.9	10,901.6	11,711.9	13,095.5	12,605.8	15,263.2	8.4
BEA 47: Huntsville, AL	438.7	482.9	537.5	533.7	608.2	782.4	720.7	914.3	11.1
BEA 48: Chattanooga, TN	846.1	904.0	948.0	965.9	1,027.2	1,178.9	1,014.0	1,245.5	5.7
BEA 49: Nashville, TN	804.9	867.8	931.0	937.5	1,000.8	1,161.1	1,025.3	1,290.0	7.0
BEA 50: Knoxville, TN	138.3	266.9	389.4	508.4	648.5	854.7	821.1	1,105.3	34.6
BEA 52: Huntington, WV	1,182.8	1,241.0	1,340.8	1,361.7	1,300.9	1,512.6	1,299.6	1,455.1	3.0
BEA 54: Louisville, KY	807.0	877.0	922.6	921.1	1,011.9	1,239.9	1,088.0	1,330.5	7.4
BEA 55: Evansville, IN	606.0	702.0	683.1	710.9	760.5	888.5	826.7	1,064.3	8.4
BEA 62: Cincinnati, OH	1,389.7	1,548.8	1,612.6	1,614.6	1,734.3	1,920.5	1,722.4	2,035.2	5.6
BEA 64: Columbus, OH	478.4	588.3	695.2	757.6	794.5	950.7	872.8	1,048.8	11.9
BEA 66: Pittsburgh, PA	1,679.8	1,891.4	2,070.3	2,207.7	2,393.4	2,877.2	2,692.2	3,085.6	9.1
BEA 68: Cleveland, OH	29.4	32.2	31.1	32.7	32.8	36.4	35.0	40.9	4.8
BEA 115: Paducah, KY	270.7	302.8	340.3	349.8	398.9	492.6	488.0	646.7	13.2

Note: Historical consumption data for industrial chemicals, 1969-76, were derived from production of the top 50 chemicals, in Chemical and Engineering News. In addition to the weekly Chemical and Engineering News, the American Chemical Society publishes Key Chemicals, The Basic Products of the Chemical Industry. This publication explains different industries' need of key chemicals. These chemicals are mainly used by industries producing chemical and allied products, textile products, paper and allied products, petroleum refining products, primary metal products and miscellaneous manufacturing products. After estimating each industry's total national requirement for sulfuric acid, benzene and toluene, sodium hydroxide, and all other industrial chemicals separately, the consumption by each industry by BEA and BEA segment was estimated according to the ratio of employment in each BEA and BEA segment to the national employment in each industry. Thus the consumption data were derived for industrial chemicals. Chemical fertilizer consumption was derived by the multiplication of harvested acres of corn, wheat and soybeans by BEA and BEA segment times the fertilizer application rates (nitrogenous (N), phosphatic (P_2O_5), and potassic (K_2O) primary nutrient pounds) for corn, wheat and soybeans times the percent of harvested acres receiving fertilizer times a factor for acres planted and fertilizer but not harvested times the tons of fertilizer material necessary to provide one ton of primary nutrient. Fertilizer material tons were derived by dividing the estimated domestic supply (domestic production + imports - exports) of N, P_2O_5 and K_2O chemical materials by the average analysis (i.e., the percentage of primary nutrients contained per unit of chemical material).

a. BEA segments are defined as counties which are ultimate origins or destinations of waterborne movements.

Source: National production data for major chemicals and industrial requirements from "Facts and Figures for the Chemical Industry," Chemical and Engineering News, 1969-78 eds. County and state employment data from the U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1970-76 eds. National employment by industry from the U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, 1909-1975, and recent updated data. Nitrogenous, potassic and phosphatic chemical fertilizer material estimated domestic supply for fertilizer use from U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, The Fertilizer Supply,

(Continued)

Table C-6. (Continued)

1968-1979 and 1977-1978. Average analyses from U.S. Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, Commercial Fertilizers, Final Consumption for the Year, ended June 30th 1976. Fertilizer application rates and the percent of acres receiving fertilizer for 1969 from U.S. Department of Agriculture, Statistical Reporting Service, Cropping Practices, 1964-70 eds. and for 1971-76 from U.S. Department of Agriculture, Economic Research Service, Fertilizer Situation, 1975 and 1978 eds.

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Table C-7. Ohio River Basin: Consumption of Ores and Minerals,[a] by BEAs and BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	5,629.5	5,702.6	5,462.9	5,913.7	5,692.6	6,418.7	5,799.6	6,720.2
BEA 47: Huntsville, AL	497.8	521.8	516.8	540.3	594.2	668.0	554.1	618.1
BEA 48: Chattanooga, TN	100.4	104.8	102.3	115.4	93.5	197.6	246.9	345.8
BEA 49: Nashville, TN	259.2	280.3	276.8	301.9	274.9	342.1	318.7	380.6
BEA 50: Knoxville, TN	526.4	557.9	551.5	589.5	615.5	698.0	586.2	657.5
BEA 52: Huntington, WV	394.8	419.0	410.5	437.1	411.8	457.7	402.7	437.4
BEA 54: Louisville, KY	146.9	158.9	154.6	168.5	135.3	163.3	161.4	180.7
BEA 55: Evansville, IN	571.9	605.4	598.4	635.6	669.5	897.5	877.8	1,118.9
BEA 62: Cincinnati, OH	185.6	208.2	206.8	230.6	178.3	209.2	209.4	235.3
BEA 64: Columbus, OH	516.8	515.3	483.7	559.6	505.8	510.2	463.1	500.4
BEA 65: Clarksburg, WV	24.7	27.8	27.3	31.4	21.5	33.3	38.8	48.9
BEA 66: Pittsburgh, PA	2,095.1	2,003.4	1,859.4	1,986.0	1,888.4	1,948.0	1,679.5	1,916.8
BEA 68: Cleveland, OH	0.7	0.7	0.7	0.8	0.8	0.8	0.9	1.0
BEA 115: Paducah, KY	309.2	299.1	274.1	317.1	303.1	293.0	260.1	278.8

a. Includes consumption of manganese, liquid sulfur, rock salt, zinc and alumina.
b. BEA segments defined as counties which are origins or destinations of waterborne movements.
Source: Consumption of manganese, liquid sulfur, rock salt, zinc, and alumina from Tables 6-10, respectively, from Group VII Report.

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Table C-8. Ohio River Basin: Consumption of Iron Ore, Iron and Steel, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment		1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas		104,188.5	96,025.6	88,638.5	99,845.2	111,092.8	108,882.0	82,458.1	89,416.1
BEA 47:	Huntsville, AL	45.2	39.6	43.5	45.7	52.1	50.5	38.0	43.1
BEA 48:	Chattanooga, TN	1,034.0	913.4	909.2	996.6	1,121.1	1,060.8	837.4	936.7
BEA 49:	Nashville, TN	561.6	512.6	535.0	565.3	644.8	622.5	471.4	532.8
BEA 50:	Knoxville, TN	464.8	412.5	400.3	463.0	516.9	508.7	384.6	439.4
BEA 52:	Huntington, WV	7,303.8	6,989.6	6,889.0	7,125.0	8,347.5	7,716.7	5,731.1	6,457.8
BEA 54:	Louisville, KY	1,115.2	1,021.9	1,072.2	1,128.4	1,286.9	1,247.3	940.2	1,064.2
BEA 55:	Evansville, IN	553.8	511.9	530.7	581.3	648.8	620.9	463.5	536.4
BEA 62:	Cincinnati, OH	9,733.7	9,238.5	9,220.4	10,197.7	10,627.5	10,447.5	7,751.5	8,744.5
BEA 64:	Columbus, OH	139.5	127.8	134.1	141.1	161.0	156.0	117.5	133.1
BEA 66:	Pittsburgh, PA	63,679.1	57,629.6	52,643.8	60,033.2	67,082.5	66,031.9	50,709.1	53,704.5
BEA 67:	Youngstown, OH	19,557.8	17,628.0	16,260.3	18,567.9	20,603.7	20,419.2	15,013.8	16,823.6

Note: Consumption figures shown include the consumption of iron ore, pig iron, steel mill products, ferroalloys, ferrous castings and ferrous scrap.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Consumption of iron ore, pig iron, steel mill products, ferroalloys, ferrous castings and ferrous scrap are shown annually by BEA segments in Table A-1 through A-6 of Group VIII Report.

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Table C-9. Ohio River Basin: Consumption of Food and Feed Products, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons unless otherwise specified)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change 1969-76
Primary Study Areas	5,068.3	5,261.8	5,038.7	4,999.9	5,025.6	4,972.8	4,769.1	4,864.3	(0.58)
BEA 47: Huntsville, AL	439.4	464.4	454.6	461.8	457.6	474.1	446.8	447.8	0.2
BEA 48: Chattanooga, TN	485.9	500.9	493.6	504.4	512.4	507.4	495.5	505.3	0.56
BEA 49: Nashville, TN	970.0	1,020.0	970.3	962.7	992.5	966.3	960.6	953.2	(0.25)
BEA 50: Knoxville, TN	317.7	325.7	318.5	332.3	342.5	344.2	345.7	350.5	1.41
BEA 54: Louisville, KY	783.8	818.5	767.9	755.3	750.8	763.3	714.2	730.5	(1.00)
BEA 55: Evansville, IN	745.5	797.8	742.0	721.9	707.2	695.3	649.6	667.7	(1.56)
BEA 62: Cincinnati, OH	802.4	807.2	781.1	761.8	769.7	735.0	704.7	741.8	(1.12)
BEA 66: Pittsburgh, PA	532.6	527.0	510.7	499.8	492.9	487.2	452.1	467.5	(1.61)

Note: Food and feed products consumed by livestock (i.e. prepared animal feed and grain mill products, nec.) were derived by multiplying the BEA segment level corn consumption in tons by all livestock categories by a factor of .234 tons. This factor represents the amount of prepared animal products and grain mill products, nec. consumed per ton of corn consumed. The resulting livestock food and feed products consumption was then multiplied by 1.3 to add an additional 30 percent to the consumption weight represented by additional commodities (fish protein, phosphates, dried milk, etc.) added in the preparation of prepared animal feeds. State totals of receipts for 1972 of food and feed products consumed as intermediate industrial goods (i.e. wheat flour, sugar, soybean oil and corn oil) were estimated from national and regional receipts of these commodities as derived from the 1972 Census of Transportation. State totals were distributed among BEA segments based on the distribution of 1972 and 1973 employment in the food and kindred products industry by state and county. Industrial consumption for 1969 to 1976 was derived by using the annual change in employment in the food and kindred products industry by state, applied to the appropriate portion of the BEA or BEA segment.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Corn consumption by livestock by BEA segment from Grains (Group V) Report adjusted for variances in Commodity Group V and IX hinterlands. Prepared animal feed and grain mill products, nec. relationship to livestock corn consumption and percentage of other commodities added to food and feed products to produce prepared animal feed from U.S. Department of Agriculture, Agricultural Statistics, 1977. Industrial consumption from U.S. Department of Commerce, Bureau of the Census, 1972 Census of Transportation and County Business Patterns, 1972, 1973 eds.

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Table C-10. Ohio River Basin: Consumption of Wood and Paper Products,[a] by BEAs or BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	11,019.0	11,232.0	11,971.7	12,836.9	11,860.6	14,365.0	13,701.0	13,247.6
BEA 47: Huntsville, AL	2,875.4	2,956.4	3,146.0	3,412.4	3,385.1	3,680.4	3,636.9	3,605.4
BEA 48: Chattanooga, TN	2,283.0	2,324.2	2,484.7	2,678.8	2,668.5	2,801.5	2,734.8	2,787.7
BEA 50: Knoxville, TN	1,918.1	1,979.0	2,101.3	2,280.8	2,262.7	3,356.5	3,207.5	2,416.7
BEA 54: Louisville, KY	895.4	889.9	956.7	1,000.7	1,021.1	929.4	831.7	974.6
BEA 62: Cincinnati, OH	1,943.7	1,970.1	2,099.1	2,224.8	2,253.3	2,222.4	2,067.4	2,244.1
BEA 66: Pittsburgh, PA	969.2	981.8	1,041.3	1,089.7	1,118.0	1,055.6	940.8	1,074.2
BEA 115: Paducah, KY	134.2	130.6	142.6	149.7	151.9	319.2	281.9	144.9

a. Wood and paper products include lumber products, pulpwood logs and paper products.
b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.
Source: Tables 7,8, and 9 of Group X Report.

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Table C-11. United States and Ohio River Basin: Consumption of Petroleum Products, Nec., by BEAs and BEA Segments, Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	48,872.0	50,929.3	50,695.6	52,608.0	56,741.3	53,519.6	47,007.7	50,318.0
Primary Study Areas	2,724.2	2,784.5	2,751.9	2,908.3	3,231.7	2,827.3	2,671.0	2,883.7
BEA 47: Huntsville, AL	165.2	165.6	162.4	175.9	193.7	165.2	149.1	158.6
BEA 48: Chattanooga, TN	158.0	161.5	156.0	170.4	198.5	164.3	161.7	166.8
BEA 49: Nashville, TN	344.5	343.1	327.7	350.6	420.5	330.4	338.5	345.1
BEA 50: Knoxville, TN	163.9	162.7	155.4	167.5	200.9	156.9	163.5	165.9
BEA 52: Huntington, W.V.	203.3	217.8	223.9	235.7	244.9	217.7	218.2	240.4
BEA 54: Louisville, KY	320.9	335.4	343.9	335.0	385.5	319.7	291.3	300.3
BEA 62: Cincinnati, OH	588.9	592.1	579.1	604.8	678.9	615.5	567.2	617.3
BEA 64: Columbus, OH	72.1	84.7	92.5	107.8	124.8	127.5	126.5	159.2
BEA 66: Pittsburgh, PA	602.0	614.7	606.1	651.7	661.7	624.2	552.9	619.8
BEA 68: Cleveland, OH	42.1	43.2	42.5	45.7	50.6	45.0	43.3	44.6
BEA 115: Paducah, KY	63.3	63.7	62.4	63.4	71.7	60.9	58.3	65.7

Note: Consumption of lubricants, asphalt and road oil, and special naphthas by BEA segments based on population and per capita consumption. Consumption of industrial naphthas were distributed among BEA segments on the basis of chemical and allied products employment.

Source: U.S. and State Consumption from U.S. Department of Interior, Bureau of Mines, Mineral Yearbook, 1970-76 and U.S. Department of Energy, Federal Energy Data System (FEDS), Technical Documentation, June 1978; Chemical and allied products employment data was from the U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1970-76; population data provided by the U.S. Department of Commerce Bureau of Economic Analysis.

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Table C-12. United States and Ohio River Basin: [a] Consumption of Lime and Portland Cement, by BEAs or BEA Segments,[a] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
United States	95,487.0	91,327.0	98,677.0	103,244.0	106,407.0	102,904.0	88,051.0	93,121.0
Primary Study Areas[b]	7,711.5	7,170.7	7,475.2	7,624.4	8,118.7	7,890.1	6,607.5	7,313.9
BEA 47: Huntsville, AL	395.2	362.3	400.3	418.6	441.4	423.7	367.8	403.9
BEA 49: Nashville, TN	491.6	488.1	545.1	566.9	576.0	609.8	472.2	481.8
BEA 50: Knoxville, TN	256.3	258.0	286.6	296.4	320.5	304.8	248.7	247.7
BEA 52: Huntington, WV	810.3	779.3	851.9	869.7	914.1	892.5	751.3	881.8
BEA 54: Louisville, KY	621.2	581.7	607.4	611.4	621.4	584.6	539.1	642.0
BEA 55: Evansville, IN	279.7	263.8	272.6	274.1	277.3	269.3	237.9	255.0
BEA 62: Cincinnati, OH	1,217.9	1,112.3	1,137.6	1,150.8	1,233.7	1,148.5	980.6	1,135.3
BEA 64: Columbus, OH	574.1	553.1	590.6	550.9	564.0	558.2	488.3	494.7
BEA 65: Clarksburg	68.6	68.8	92.6	81.9	101.5	98.3	82.5	84.2
BEA 66: Pittsburgh, PA	2,853.8	2,578.9	2,521.5	2,634.4	2,887.0	2,836.8	2,294.6	2,533.2
BEA 68: Cleveland, OH	70.7	60.0	62.8	63.8	72.6	63.5	54.7	54.5
BEA 115: Paducah, KY	72.1	64.4	106.2	105.5	109.2	100.1	89.8	99.8

Note: Consumption by BEAs and BEA segments of portland cement were derived from state portland cement consumption distributed among BEAs and BEA segments on the basis of the 1969-76 distribution of population of counties. Consumption of lime by the steel industry was derived from the usage of lime per ton of steel produced by various furnace types and estimates of steel production by BEA and BEA segment. Consumption of lime by the chemical industry obtained from state consumption by the chemical industry allocated among BEAs and BEA segments on the basis of the distribution of chemical production.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.
b. Columns may not add to totals due to rounding.

Source: Estimated from U.S. Department of the Interior, Bureau of Mines: "Cement" and "Lime," Minerals Yearbook, 1969-76 eds.; from annual county population statistics provided by U.S. Department of Commerce, Bureau of Economic Analysis, 1969-76; from American Iron and Steel Institute, Annual Statistical Report, 1969-76; and from Iron Ore, Steel and Iron (Group VIII) Report and Chemicals and Chemical Fertilizers (Group VI) Report.

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Table C-13. Ohio River Basin: Consumption of Nonferrous Metals and Alloys,[a] by BEAs or BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA or BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	1,329.7	1,261.9	1,248.3	1,398.5	1,610.9	1,609.0	1,136.5	1,464.1
BEA 48: Chattanooga, TN	102.6	95.7	97.7	109.4	125.5	124.4	85.2	109.8
BEA 49: Nashville, TN	156.6	145.1	152.4	171.3	194.8	189.9	138.9	188.4
BEA 50: Knoxville, TN	31.8	30.2	28.3	31.8	36.3	34.5	24.6	29.6
BEA 52: Huntington, WV	129.9	124.2	124.7	138.5	161.8	194.8	150.9	229.2
BEA 55: Evansville, IN	186.3	173.4	183.5	205.1	236.1	240.1	169.0	230.1
BEA 62: Cincinnati, OH	191.1	178.4	182.3	206.5	235.5	222.9	157.3	199.0
BEA 66: Pittsburgh, PA	531.4	514.9	479.4	536.0	620.9	602.4	410.6	478.8

Note: Consumption of primary aluminum and primary copper by BEAs or BEA segments was calculated from total U.S. consumption and the employment distribution of the industries that consume these two primary metals. The employment distribution ratios were obtained by dividing the number of foundry and mill employees in each BEA or BEA segment by the total U.S. mill and foundry employment of each of these two metals. Consumption of primary lead, primary zinc, aluminum and copper products was estimated according to the employment distribution of their end-use markets among the BEA segments. Consumption of the remaining metals was calculated according to the employment distribution of the entire primary metal industry among the BEAs and BEA segments.

a. Includes the primary metal of aluminum, copper, lead, zinc, nickel, titanium, magnesium, tin, antimony, beryllium, chromium, manganese, and cadmium, and primary products of aluminum, copper, and molybdenum.

b. BEA segments are defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, 1972-78 eds.; U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures, 1976; American Metal, Market Statistics, 1971-78 eds.; The Aluminum Association, Aluminum Statistical Review, 1977 ed.; U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1973, 1974, 1976 eds.

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Table C-14. Ohio River Basin: Consumption of Selected Manufactured Products,[a] by BEAs or BEA Segments,[b] Estimated 1969-76

(Thousands of tons)

BEA and BEA segment		1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas		3,690.1	3,898.4	4,111.4	4,523.4	5,053.1	5,521.1	5,860.2	6,546.8
BEA 47:	Huntsville, AL	172.7	184.5	199.3	220.5	244.8	261.3	275.3	311.5
BEA 48:	Chattanooga, TN	195.0	205.6	225.3	260.1	298.1	317.5	329.9	381.0
BEA 49:	Nashville, TN	392.0	412.3	444.2	503.7	584.9	639.3	663.4	760.6
BEA 50:	Knoxville, TN	169.2	180.1	196.1	218.5	244.7	268.3	286.0	326.9
BEA 52:	Huntington, WV	253.2	274.2	294.4	316.2	355.2	392.1	430.6	491.6
BEA 54:	Louisville, KY	382.0	400.6	419.2	459.4	509.8	547.1	566.5	621.2
BEA 55:	Evansville, IN	228.6	236.8	256.0	284.9	328.8	355.3	389.5	436.7
BEA 62:	Cincinnati, OH	824.7	869.4	895.5	966.0	1,069.5	1,159.8	1,222.6	1,348.4
BEA 64:	Columbus, OH	100.9	108.3	114.2	123.3	136.3	154.0	157.1	175.5
BEA 65:	Clarksburg, WV	46.9	51.5	58.0	67.2	70.3	77.0	84.4	92.5
BEA 66:	Pittsburgh, PA	875.4	922.1	951.1	1,040.8	1,140.2	1,272.9	1,372.7	1,510.6
BEA 115:	Paducah, KY	48.5	53.0	58.1	62.8	71.2	76.5	82.2	90.3

Note: Receipts of selected manufactured goods (SIC 34, 35, 36, 3731 and 3732) for different regions from U.S. Department of Commerce, Bureau of the Census, Census of Transportation, and distributed among states on the basis of employment distribution. Estimates of selected manufactured products consumption by BEA and BEA segment was obtained by multiplying annual earnings of each BEA and BEA segment by the ratio of selected manufactured goods consumption to total earnings by state in 1972.

a. Includes fabricated metal, machinery products, electrical machinery products, ships and boats.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Commerce, Bureau of the Census, Census of Transportation, 1972 ed., and County Business Patterns, 1972 ed. Annual county earnings by industry provided by U.S. Department of Commerce, Bureau of Economic Analysis.

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Table C-15. Ohio River Basin: Consumption of Others, Nec., by Commodity Types and BEAs or BEA Segments[A], 1969-1976

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	5,780.9	5,155.3	4,521.5	4,975.4	5,770.9	5,862.1	5,170.0	5,373.9
Petro, coal products	2,912.1	2,680.5	2,499.6	2,790.5	3,113.6	3,083.0	2,503.3	2,803.4
Slag, iron and steel	1,956.7	1,767.9	1,738.8	1,822.7	2,057.6	1,988.9	1,666.7	2,000.0
Waterway improvement materials	912.1	706.9	283.1	362.2	599.7	790.2	1,000.0	570.5
BEA 47: Huntsville, AL	135.1	122.4	130.9	128.0	153.4	144.8	129.3	160.5
Petro, coal products	12.1	11.1	11.4	11.7	14.6	17.6	22.3	31.6
Slag, iron and steel	122.4	111.3	110.0	116.3	131.7	127.2	107.0	128.9
Waterway improvement materials	0.6	--	9.5	--	7.1	--	--	--
BEA 49: Nashville, TN	274.3	249.5	248.1	286.4	309.2	305.9	273.7	341.9
Petro, coal products	24.7	22.6	23.3	24.0	30.3	37.2	47.1	67.3
Slag, iron and steel	249.6	226.9	224.5	238.7	273.2	268.7	226.2	274.6
Waterway improvement materials	--	--	0.3	23.7	5.7	--	0.4	--
BEA 52: Huntington, WV	585.1	414.7	413.8	440.5	575.2	463.7	379.5	452.9
Petro, coal products	249.2	239.1	237.3	260.9	284.6	268.9	215.0	253.3
Slag, iron and steel	191.7	172.0	169.5	179.1	201.4	194.5	164.5	199.6
Waterway improvement materials	144.2	3.6	7.0	0.5	89.2	0.3	--	--
BEA 54: Louisville, KY	329.4	229.0	291.0	287.2	304.8	272.4	222.1	274.4
Petro, coal products	21.1	19.3	19.8	20.0	25.0	30.3	38.3	54.0
Slag, iron and steel	213.3	193.9	191.1	198.7	225.2	219.1	183.8	220.4
Waterway improvement materials	95.0	15.8	80.1	68.5	54.6	23.0	--	--
BEA 55: Evansville, IN	185.7	209.6	201.9	339.7	242.7	229.6	302.3	170.2
Petro, coal products	24.4	23.1	23.3	24.8	28.7	30.7	32.0	42.5
Slag, iron and steel	123.9	111.7	110.1	115.2	130.4	126.4	106.0	127.7
Waterway improvement materials	37.4	74.8	68.5	199.7	83.6	72.5	164.3	--
BEA 62: Cincinnati, OH	655.4	612.0	602.2	681.8	722.7	686.3	568.5	679.3
Petro, coal products	315.4	304.5	300.4	329.0	360.8	341.5	281.2	334.1
Slag, iron and steel	339.8	307.5	301.8	315.2	357.4	344.8	287.3	342.8
Waterway improvement materials	0.2	--	--	37.6	4.5	--	--	2.4

(Continued)

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Table C-15. (Continued)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
BEA 64: Columbus, OH	110.7	652.3	78.7	64.5	309.5	95.4	91.1	79.1
Petro, coal products	6.0	5.6	5.7	5.9	7.3	8.8	11.1	15.6
Slag, iron and steel	60.9	56.0	55.3	58.4	65.8	63.4	53.1	63.5
Waterway improvement materials	43.8	590.7	17.7	0.2	236.4	23.2	26.9	--
BEA 66: Pittsburgh, PA	3,403.2	2,619.9	2,489.9	2,689.0	3,096.9	3,017.4	2,355.7	2,595.8
Petro, coal products	2,255.3	2,051.7	1,874.8	2,110.5	2,357.7	2,342.4	1,849.2	1,994.8
Slag, iron and steel	615.9	553.2	541.3	564.2	630.9	604.4	504.5	601.0
Waterway improvement materials	532.0	15.0	73.8	14.3	108.3	70.6	2.0	--
BEA 115: Paducah, KY	102.0	45.9	65.0	58.3	56.5	646.6	847.8	619.8
Petro, coal products	3.9	3.5	3.6	3.7	4.6	5.6	7.1	10.2
Slag, iron and steel	39.2	35.4	35.2	36.9	41.6	40.4	34.3	41.5
Waterway improvement materials	58.9	7.0	26.2	17.7	10.3	600.6	806.4	568.1

Note: Petroleum and coal products, nec., consist of wax and miscellaneous petroleum products and coal products. The U.S. consumption of petroleum products and slags are allocated to BEA segments on the basis of population distribution. Consumption of coal products for the ORB as a region is assumed to equal its production. Distribution of coal products to the BEA segments was made based on the tonnage of steel produced in each BEA. Waterway improvements materials consumption is assumed to equal the receipt of the materials via the waterways.

a. Segments defined as counties which are ultimate origins or destination of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, various years; Coal (Group I) Report; population data in computer tapes supplied by U.S. Department of Commerce, Bureau of Economic Analysis; Waterborne Commerce by Port Equivalents, 1969 -76, supplied by U.S. Army Corps of Engineers.

APPENDIX D

Table D-1. Ohio River Basin: Coal Production by BEAs or BEA Segments[a], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-90	1976-2040
Primary Study Areas	436,998.0	481,431.0	627,200.0	763,547.8	931,672.6	1,136,818.3	2.61	1.51
BEA 47: Huntsville, AL	203.0	200.0	200.0	243.5	297.1	362.5	(0.11)	0.91
BEA 48: Chattanooga, TN	2,452.0	2,572.9	2,900.0	3,530.4	4,307.8	5,256.3	1.21	1.20
BEA 49: Nashville, TN	1,395.0	1,609.5	2,300.0	2,800.0	3,416.5	4,168.8	3.64	1.73
BEA 50: Knoxville, TN	26,671.0	29,577.9	38,300.0	46,626.1	56,892.6	69,419.9	2.62	1.51
BEA 51: Bristol, VA	51,265.0	54,747.3	73,200.0	89,113.0	108,734.7	132,677.1	2.58	1.50
BEA 52: Huntington, WV	97,813.0	111,982.6	157,000.0	191,130.4	233,215.2	284,567.1	3.44	1.68
BEA 53: Lexington, KY	33,829.0	37,501.4	48,500.0	59,043.5	72,044.2	87,907.7	2.61	1.50
BEA 54: Louisville, KY	11.0	--	--	--	--	--	b	b
BEA 55: Evansville, IN	73,564.0	85,927.1	126,700.0	154,243.5	188,206.2	229,647.4	3.96	1.79
BEA 62: Cincinnati, OH	--	--	--	--	--	--	--	--
BEA 64: Columbus, OH	13,345.0	14,052.6	16,000.0	19,478.3	23,767.2	29,000.5	1.30	1.22
BEA 65: Clarksburg, WV	30,367.0	32,999.3	40,600.0	49,426.1	60,309.2	73,588.7	2.10	1.39
BEA 66: Pittsburgh, PA	104,777.0	108,901.9	120,000.0	146,086.9	178,253.7	217,503.5	0.97	1.15
BEA 68: Cleveland, OH	1,306.0	1,358.5	1,500.0	1,826.1	2,228.2	2,718.8	0.99	1.15
BEA 115: Paducah, KY	--	--	--	--	--	--	--	--

Note: Tonnages for 1980 derived by interpolation of 1976-90 area and BEA segment growth rates. Tonnages for 1976 from Table 21. Tonnages for 1990 were derived from Department of Energy projections. DOE projections of production were made on the basis of 12 supply regions. BEA shares of these 12 supply region projections were based on the BEA shares of production from these regions in 1976. The shares from 1976 were applied to the 1990 regional production projects. Tonnages for the year 2000 obtained by applying the ICF reference case 1990-2000 growth rate in Appalachian coal production to the tonnages for 1990. Growth rate for 2000-2040 assumed to be one-half the two percent ICF 1990-2000 growth rate.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

b. No production in 1976.

Source: U.S. Department of Energy, "Appendix" Annual Report to Congress, 1977 ed., Vol. II.; ICF Inc., "Summary of Forecasts of ICF's Coal and Electric Utility Model for the Energy Modeling Forum," Coal in Transition, 1978 ed.

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Table D-2. Ohio River Basin: Production of Petroleum Fuels by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons, unless otherwise indicated)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	15,841.7	18,162.3	24,509.0	22,916.0	17,530.7	10,202.9	3.17	(0.69)
BEA 47: Huntsville, AL	--	--	--	--	--	--	--	--
BEA 48: Chattanooga, TN	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	--	--	--	--	--	--	--	--
BEA 50: Knoxville, TN	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV	5,536.7	6,377.4	8,688.3	8,123.6	6,214.6	3,616.9	3.27	(0.66)
BEA 53: Lexington, KY	125.4	--	--	--	--	--	--	--
BEA 54: Louisville, KY	1,035.0	1,165.3	1,662.9	1,554.8	1,189.4	692.2	3.44	(0.63)
BEA 55: Evansville, IN	5,842.0	6,590.4	9,287.2	8,683.5	6,642.9	3,866.2	3.37	(0.64)
BEA 62: Cincinnati, OH	2,845.7	3,179.8	4,546.5	4,251.0	3,252.0	1,892.7	3.40	(0.64)
BEA 64: Columbus, OH	146.3	302.9	103.6	96.9	74.1	43.1	(2.44)	(1.89)
BEA 65: Clarksburg, WV	--	--	--	--	--	--	--	--
BEA 66: Pittsburgh, PA	310.6	546.3	220.5	206.2	157.7	91.8	(2.42)	(1.89)
BEA 68: Cleveland, OH	--	--	--	--	--	--	--	--
BEA 115: Paducah, KY	--	--	--	--	--	--	--	--

Note: The production estimates for each BEA or BEA segment are computed by multiplying the 1976 estimates by the appropriate growth rates of crude petroleum consumption.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Table B-2, and Crude Petroleum (Group III) Report.

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Table D-3. Ohio River Basin: Production of Crude Petroleum by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	2,153.8	2,097.6	2,041.9	1,846.7	1,232.9	554.9	(0.38)	(2.10)
BEA 55: Evansville, IN	2,082.7	1,834.3	1,842.9	1,666.7	1,112.7	491.8	(0.87)	(2.23)
BEA 64: Columbus, OH	27.5	66.2	61.5	55.6	37.1	16.4	5.92	(0.80)
BEA 66: Pittsburgh, PA	43.6	197.1	137.5	124.4	83.1	36.7	8.55	(0.27)

Note: The production of crude petroleum for 1980 is projected based on the average annual growth rates of the BEAs for the 1974-80 period provided in the Oak Ridge report, adjusted for the latest projection (series C), made by the U.S. Department of Energy (DOE). The 1990 projections are derived from the national production estimated by DOE and distributed to the BEAs by 1985 allocation factors provided by Oak Ridge. For post-1990 decades, the rate of decrease in crude oil production is assumed to be twice that of the preceding period. This assumption implies the complete depletion of the U.S. oil reserve in the year 2100.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Energy, Energy Information Administration, Annual Report to Congress, Vol. II, 1977 ed. and Oak Ridge National Laboratory, Energy Availabilities for State and Local Development: Projected Energy Patterns for 1980 and 1985, June 1978.

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Table D-4. Ohio River Basin: Production of Aggregates, by BEAs or BEA Segments[a], Estimated Average 1974-76, and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated average 1974-76	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	127,955.1	135,611.3	156,594.5	172,248.3	204,570.7	222,546.3	1.2	0.6
BEA 47: Huntsville, AL	6,010.2	6,928.0	8,795.8	10,575.5	13,845.5	15,663.2	2.3	1.0
BEA 48: Chattanooga, TN	7,284.8	7,909.8	9,175.0	10,004.3	11,997.3	13,093.8	1.3	0.7
BEA 49: Nashville, TN	18,600.0	17,036.8	18,618.1	19,217.0	23,960.6	26,562.4	0.1	0.8
BEA 50: Knoxville, TN	10,264.1	10,712.6	11,212.1	11,187.7	12,625.8	13,402.1	0.4	0.5
BEA 52: Huntington, WV	6,782.0	7,677.7	8,834.2	9,761.2	10,347.1	10,664.7	1.5	0.2
BEA 53: Lexington, KY	6,515.1	6,576.0	6,789.4	6,605.2	7,751.9	8,373.1	0.1	0.6
BEA 54: Louisville, KY	17,805.6	18,543.3	20,761.2	22,126.1	27,433.9	30,368.8	0.9	0.8
BEA 55: Evansville, IN	6,596.8	6,839.4	8,423.1	9,270.2	10,902.5	11,799.0	1.4	0.6
BEA 62: Cincinnati, OH	16,501.7	18,820.2	23,374.3	27,374.3	33,262.9	36,702.8	2.1	0.7
BEA 64: Columbus, OH	1,700.7	1,229.9	1,783.9	2,316.9	2,809.3	3,076.5	1.2	0.7
BEA 65: Clarksburg, WV	2,352.6	2,717.9	3,413.4	3,889.3	4,373.5	4,636.1	2.0	0.4
BEA 66: Pittsburgh, PA	19,764.1	21,823.1	24,006.3	27,284.2	30,588.8	32,411.0	1.3	0.4
BEA 68: Cleveland, OH	1,911.1	1,804.9	2,163.5	2,514.3	2,964.3	3,210.6	1.1	0.6
BEA 115: Paducah, KY	5,866.3	6,991.0	9,168.2	10,122.1	11,707.3	12,582.2	2.2	0.6

Note: Production assumed to be equal to consumption plus net shipment. Total Primary Study Area waterborne receipts were projected as a proportion of total PSA projected consumption. Projection of outbound traffic is based partly on historical pattern and partly on field information. Projection of inbound traffic is based on historical pattern. Primary Study Area shipments were allocated among BEAs and BEA segments according to their probable potential reserves of material. Projections of net rail shipments were assumed to be equal to a constant proportion of total consumption.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Tables 8 and 11 of Group IV Report, RRNA estimates of net shipments by BEA and BEA segments, as noted above.

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Table D-5. Ohio River Basin: Production of Grains,[a] by BEAs or BEA Segments,[b] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-76--2000	2000-2040
Primary Study Areas	25,576.9	19,859.7	25,199.4	32,549.6	39,361.2	46,719.5	1.01	0.91
BEA 44: Atlanta, GA	87.7	113.3	154.5	270.5	328.8	392.6	4.80	0.94
BEA 45: Birmingham, AL	418.0	439.4	637.0	905.5	1,049.8	1,201.4	3.27	0.71
BEA 46: Memphis, TN	483.1	477.8	582.6	762.5	839.1	916.9	1.92	0.46
BEA 47: Huntsville, AL	643.1	663.0	930.9	1,359.6	1,541.3	1,727.2	3.17	0.60
BEA 48: Chattanooga, TN	378.4	311.9	436.3	618.3	698.8	782.0	2.07	0.59
BEA 49: Nashville, TN	1,949.8	1,765.8	2,210.2	3,040.0	3,432.8	3,836.6	1.87	0.58
BEA 50: Knoxville, TN	118.0	65.5	89.3	126.4	150.3	176.5	0.29	0.84
BEA 52: Huntington, WV	105.4	79.8	100.4	118.7	133.4	148.6	0.50	0.56
BEA 53: Lexington, KY	427.4	302.4	377.2	499.3	574.4	655.7	0.65	0.68
BEA 54: Louisville, KY	1,173.7	1,060.3	1,300.8	1,731.5	2,237.5	2,808.4	1.63	1.22
BEA 55: Evansville, IN	5,594.6	2,450.0	3,453.1	4,873.2	6,831.0	9,082.0	(0.57)	1.57
BEA 56: Terre Haute, IN	498.1	393.6	497.0	643.0	878.5	1,141.8	1.07	1.45
BEA 60: Indianapolis, IN	3,998.0	3,582.5	4,015.8	4,612.4	5,872.1	7,128.9	0.60	1.09
BEA 61: Anderson, IN	600.7	247.9	323.4	426.9	613.4	817.3	(1.41)	1.64
BEA 62: Cincinnati, OH	2,036.6	1,771.5	2,200.1	2,647.1	3,088.6	3,537.0	1.10	0.73
BEA 63: Dayton, OH	2,845.0	2,636.3	3,380.0	4,037.6	4,465.3	4,892.8	1.47	0.48
BEA 64: Columbus, OH	2.446.7	1,934.0	2,479.4	2,961.2	3,275.6	3,589.7	0.80	0.48
BEA 114: St. Louis, MO	672.1	723.1	839.1	1,165.5	1,349.2	1,545.8	2.32	0.71
BEA 115: Paducah, KY	1,100.5	841.6	1,192.3	1,750.4	2,001.3	2,338.3	1.95	0.73

Note: Individual items may not add to total due to rounding. Data assembled on a county level and aggregated into BEAs and BEA segments.

a. Total production of corn, wheat, and soybeans only. Corn is corn for grain. Wheat is all wheat. Soybeans are soybeans for beans.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Agriculture, Economic Research Service, USDA National-Interregional Agricultural Projections (NIRAP) System, July 1978.

This source provides state level projections of grain production to 2000. Bushels of grain produced by each of the eight states of Alabama, Georgia, Illinois, Indiana, Kentucky, Mississippi, Ohio and Tennessee were averaged for 1974, 1975 and 1976 and represent base year production. The base year production level was subtracted from the 2000 production projections. This difference was allocated to 2040 for corn and wheat. The base year production for soybeans was subtracted from 2000 production projections and divided by three. This total was allocated to 2040. For each BEA and BEA segment the percentage of the respective states' total grain production (1969-1976) was estimated and was projected into the future using trend analysis, in conjunction with expert judgement. The percent of the states' total grain production allocated to each BEA and BEA segment by period (1980 to 2040) was multiplied times the state totals to estimate grain production by BEA and BEA segment. The yield per acre as estimated by USDA was divided into the bushels of grain to equal acres. This procedure has estimated acres in cropland in 2040 to be equal to or less than acres suitable for cropland as reported in Table 26 of Group V Report. Estimated production figures for 1976 from Table B-5.

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Table D-6. Ohio River Basin: Production of Industrial and Agricultural Chemicals, by BEAs or BEA Segments,[a] Estimated Average 1974-76 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated average 1974-76	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1974-76--2000	2000-2040
Primary Study Areas	9,491.1	11,964.9	16,974.5	24,068.3	43,398.8	58,506.7	3.7	2.2
BEA 47: Huntsville, AL	946.3	1,280.8	2,142.5	3,330.5	6,717.2	9,568.9	5.2	2.7
BEA 48: Chattanooga, TN	433.3	583.7	881.6	1,291.3	2,415.0	3,310.8	4.5	2.4
BEA 49: Nashville, TN	359.3	425.9	546.3	727.7	1,208.9	1,560.6	2.9	1.9
BEA 50: Knoxville, TN	327.2	403.9	584.2	834.4	1,512.9	2,041.7	3.8	2.3
BEA 52: Huntington, WV	1,716.3	2,068.1	2,508.7	3,233.4	5,145.3	6,499.4	2.6	1.8
BEA 54: Louisville, KY	1,235.7	1,551.7	2,182.5	3,063.8	5,437.7	7,259.1	3.7	2.2
BEA 55: Evansville, IN	314.0	382.4	515.4	704.9	1,215.0	1,598.2	3.3	2.1
BEA 62: Cincinnati, OH	1,247.4	1,597.3	2,382.7	3,466.4	6,433.2	8,784.9	4.2	2.4
BEA 64: Columbus, OH	1,195.3	1,535.7	2,286.4	3,323.1	6,155.3	8,397.1	4.2	2.3
BEA 66: Pittsburgh, PA	1,172.0	1,454.9	1,984.0	2,739.7	4,750.3	6,266.9	3.5	2.1
BEA 68: Cleveland, OH	15.2	18.6	24.7	33.5	56.9	74.3	3.2	2.0
BEA 115: Paducah, KY	529.1	661.9	935.5	1,319.6	2,351.1	3,144.8	3.7	2.2

Note: The 1974-76 three years average of estimated production of industrial chemicals, agricultural chemicals and miscellaneous chemicals (SIC 281, 287, 289) were projected for 1980-2020 using the growth rates of earnings in the chemical and allied products industry as projected by U.S. Department of Commerce, OBERS Projections. Production by BEA and BEA segment was assumed to increase between 2020 and 2040 at rates equal to half the growth rates projected for the period 2000-2020.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Average production for 1974-76 from Table B-6. Average annual growth rates were derived from U.S. Water Resources Council, OBERS Projections, Regional Economic Activity in the U.S., Series E, 1972 ed., Vol. II.

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Table D-7. Ohio River Basin: Production of Zinc Ore, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segments	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	82.5	88.8	119.3	178.6	296.1	490.9	3.3	2.6
BEA 48: Chattanooga, TN	5.7	6.1	8.2	12.3	20.4	33.8	3.3	2.6
BEA 49: Nashville, TN	18.4	19.8	26.6	39.8	66.0	109.4	3.3	2.6
BEA 50: Knoxville, TN	58.4	62.9	84.5	126.5	209.7	347.7	3.3	2.6

Note: Growth rates for U.S. mine production of zinc were obtained from the Bureau of Mines, Mineral Facts and Problems, 1975 ed., Table 9. These growth rates were then applied to the RRNA estimates of zinc ore production for 1976.

a. BEA segments defined as counties which are origins or destinations of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Mineral Facts and Problems, 1975 ed. Production of zinc ore by BEA or BEA segment for 1976 from Table B-7.

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Table D-8. Ohio River Basin: Production of Iron Ore, Iron and Steel Products, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	67,721.4	75,252.9	76,461.9	84,765.1	107,434.2	123,200.6	1.0	0.9
BEA 48: Chattanooga, TN	1,064.4	1,245.2	1,868.5	2,192.7	3,015.8	3,537.0	3.1	1.2
BEA 49: Nashville, TN	340.8	397.4	643.8	743.7	1,006.1	1,171.1	3.3	1.1
BEA 50: Knoxville, TN	340.0	393.2	492.6	575.5	779.4	907.7	2.2	1.1
BEA 52: Huntington, WV	5,438.4	6,555.6	7,748.7	8,978.6	12,035.4	13,968.7	2.1	1.1
BEA 54: Louisville, KY	0.3	0.3	0.5	0.6	0.8	0.9	2.9	1.0
BEA 55: Evansville, IN	528.7	618.6	952.1	1,115.7	1,532.5	1,798.1	3.2	1.2
BEA 62: Cincinnati, OH	5,928.9	6,999.0	7,239.2	8,149.6	10,644.4	12,170.7	1.3	1.0
BEA 64: Columbus, OH	503.5	555.3	682.1	806.7	1,149.8	1,374.3	2.0	1.3
BEA 66: Pittsburgh, PA	40 725.2	46,202.5	44,405.8	47,947.5	58,188.0	66,223.5	0.7	0.8
BEA 67: Youngstown, OH	12,549.3	11,912.9	11,868.7	13,583.8	18,053.6	20,773.7	0.4	1.1
BEA115: Paducah, KY	301.9	372.9	519.9	670.7	1,028.4	1,274.9	3.4	1.6

Note: Production of iron ore, iron and steel products were projected for 1980-2040 on an individual commodity basis. Production totals shown include pig iron production from Table A-18, steel production from Table A-19, iron and steel scrap production from Table A-22, ferroalloy production from Table A-20, and foundry production from Table A-21.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Production of the iron ore, iron and steel commodity group shown in Tables A-18 through A-22 of Group VIII Report.

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Table D-9. Ohio River Basin: Production of Food and Feed Products, by BEAs or BEA Segments,[a] Estimated Average 1974-76 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated average 1974-76	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1974-76—2000	2000-2040
Primary Study Areas	3,184.9	4,252.6	5,099.0	6,082.0	8,462.0	10,035.0	2.62	1.26
BEA 47: Huntsville, AL	1,090.2	1,877.1	2,221.1	2,622.5	3,645.3	4,348.7	3.57	1.27
BEA 48: Chattanooga, TN	1,083.6	1,245.3	1,540.4	1,859.5	2,589.7	3,055.2	2.18	1.25
BEA 49: Nashville, TN	148.6	168.3	214.0	265.8	385.0	464.2	2.35	1.40
BEA 50: Knoxville, TN	41.8	47.3	58.1	70.9	101.7	122.0	2.14	1.37
BEA 54: Louisville, KY	355.9	397.8	465.3	552.9	764.0	899.6	1.78	1.22
BEA 55: Evansville, IN	458.7	509.9	591.8	700.4	962.1	1,128.4	1.71	1.20
BEA 62: Cincinnati, OH	6.1	6.9	8.3	10.0	14.2	16.9	2.00	1.32
BEA 66: Pittsburgh, PA	--	--	--	--	--	--	--	--

Note: Individual items may not add to total due to rounding. The 1974-76 three year average of actual production of food and feed products was projected for 1980-2040 using the growth rate of earnings in the food and kindred products industry as projected by U.S. Department of Commerce, OBERS Projections.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Production of food and feed products by BEA segment for 1974-76 from Table B-9. Average annual growth rates were derived from U.S. Water Resources Council, 1972 OBERS Projections, Regional Economic Activity in the U.S., Vol. II.

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Table D-10. Ohio River Basin: Production of Wood and Paper Products, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated	Projected					Average annual percentage change	
	1976[b]	1980[c]	1990[c]	2000[c]	2020[d]	2040[d]	1976-1990	1976-2040
Primary Study Areas	5,788.2	6,922.7	9,049.7	11,407.6	16,796.1	20,808.0	3.24	2.02
BEA 47: Huntsville, AL	2,196.3	2,727.9	3,617.6	4,586.3	6,849.3	8,534.1	3.63	2.14
BEA 48: Chattanooga, TN	1,822.1	2,097.7	2,648.8	3,272.4	4,760.2	5,844.9	2.71	1.84
BEA 50: Knoxville, TN	814.6	1,012.4	1,435.1	1,899.7	2,999.5	3,877.8	4.13	2.47
BEA 54: Louisville, KY	367.5	416.5	507.6	608.9	759.3	855.0	2.33	1.33
BEA 62: Cincinnati, OH	208.3	222.3	268.1	324.1	454.3	545.6	1.82	1.52
BEA 66: Pittsburgh, PA	223.0	260.7	335.6	420.0	564.6	661.9	2.96	1.71
BEA 115: Paducah, KY	156.4	185.2	236.9	296.2	408.9	488.7	3.01	1.80

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.
b. Estimated 1976 production from Table B-10. Wood and paper products include pulpwood logs, lumber products and paper products.
c. Production of lumber products projected assuming the same growth rates as those of roundwood production. BEA roundwood production growth for 1976-80, 1980-90, 1990-2000-2020, computed by applying state growth rates to BEAs within each state. Pulpwood production projected using the same method, but applying the state growth rates for pulpwood production. Paper production growth rates based on OBERS projections of earnings in the paper products industry, by BEA, and the U.S. ratios of paper products earnings to production in the paper products industry. BEA segments production growth in the 2020-2040 period assumed one-half the growth rates of the 2000-2020 period.

Source: U.S. Water Resource Council, 1972 OBERS Projections, Volumes 1 and 2; U.S. Department of Commerce, Bureau of Domestic Commerce, data on file, and RRNA estimates.

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Table D-11. Ohio River Basin: Production of Petroleum Products, Nec., by BEAs or BEA Segments[a], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	1,026.9	1,918.7	2,272.2	2,124.5	1,625.3	945.9	5.84	(0.13)
BEA 47: Huntsville, AL	--	--	--	--	--	--	--	--
BEA 48: Chattanooga, TN	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	--	--	--	--	--	--	--	--
BEA 50: Knoxville, TN	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV	576.3	1,260.8	1,717.6	1,605.9	1,228.5	714.9	8.11	0.34
BEA 54: Louisville, KY	92.3	108.1	154.3	144.3	110.4	64.3	3.74	(0.56)
BEA 62: Cincinnati, OH	164.5	183.8	262.8	245.7	188.0	109.4	3.40	(0.64)
BEA 64: Columbus, OH	81.2	168.0	57.5	53.8	41.2	24.0	(2.44)	(1.89)
BEA 66: Pittsburgh, PA	112.6	198.0	80.0	74.8	57.2	33.3	(2.41)	(1.89)
BEA 68: Cleveland, OH	--	--	--	--	--	--	--	--
BEA 115: Paducah, KY	--	--	--	--	--	--	--	--

Note: Projections of all BEAs except BEA 52 were derived by applying the growth rates of petroleum fuels (Group II) production to the 1976 estimates of petroleum products, nec., production. BEA 52 production estimates for 1980 were based on discussions with industrial authorities in this BEA. Projections for BEA 52 for later decades were made assuming the growth rates of petroleum products production equal those of petroleum fuels.

a. Segments defined as counties which are ultimate origins and destinations of waterborne movements.

Source: Table B-11. Petroleum Fuels (Group II) Report, and discussions with industrial authorities.

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Table D-12. Ohio River Basin: Production of Portland Cement and Lime, by BEAs or BEA Segments[a], Estimated Average 1974-76 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated average 1974-76	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1974-76—2000	2000-2040
Primary Study Areas	4,134.0	6,047.0	8,562.0	10,520.0	12,428.0	13,545.0	3.8	0.6
BEA 47: Huntsville, AL	155.0	171.0	234.0	296.0	326.0	342.0	2.6	0.4
BEA 49: Nashville, TN	155.0	171.0	234.0	296.0	326.0	342.0	2.6	0.4
BEA 50: Knoxville, TN	479.0	551.0	764.0	956.0	1,078.0	1,145.0	2.8	0.5
BEA 52: Huntington, WV	329.0	337.0	462.0	584.0	642.0	673.0	2.3	0.4
BEA 54: Louisville, KY	749.0	874.0	1,199.0	1,515.0	1,667.0	1,749.0	2.9	0.4
BEA 62: Cincinnati, OH	417.0	1,600.0	2,404.0	2,604.0	3,754.0	4,346.0	7.9	1.1
BEA 66: Pittsburgh, PA	1,230.0	1,537.0	2,159.0	2,672.0	3,098.0	3,336.0	3.2	0.6
BEA 115: Paducah, KY	620.0	806.0	1,106.0	1,397.0	1,537.0	1,612.0	3.3	0.4

Note: Portland cement production for each producing BEA and BEA segment was assumed to increase at the same rate as projected consumption of portland cement for the Basin as a whole. Lime production for each producing BEA and BEA segment (except BEA 62) is assumed to increase at the same rate as projected lime consumption for the Basin as a whole. Production of lime in BEA 62, where two new large plants have been installed during the study period, is expected to attain a level close to planned capacity by 1980, then increase at the same rate as projected lime consumption for the Basin as a whole.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Estimated from Table B-12, adjusted on the basis of unpublished data from the U.S. Department of the Interior, Bureau of Mines.

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Table D-13. Ohio River Basin:[a] Production of Nonferrous Metals and Alloys, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	2,771.2	3,610.4	6,692.4	9,909.1	18,407.2	25,236.1	5.5	2.4
BEA 48: Chattanooga, TN	225.1	263.8	517.0	768.2	1,420.1	1,935.4	5.2	2.3
BEA 49: Nashville, TN	215.3	300.7	677.4	1,061.1	2,091.1	2,946.8	6.8	2.6
BEA 50: Knoxville, TN	500.8	646.0	1,122.4	1,597.1	2,807.1	3,728.9	5.0	2.1
BEA 52: Huntington, WV	300.8	388.7	649.6	910.1	1,574.9	2,075.7	4.7	2.1
BEA 55: Evansville, IN	717.0	1,117.8	2,626.9	4,202.1	8,426.2	11,968.2	7.6	2.7
BEA 62: Cincinnati, OH	99.2	119.0	172.5	228.7	371.1	473.9	3.5	1.8
BEA 66: Pittsburgh, PA	683.0	774.4	926.6	1,141.8	1,716.7	2,107.2	2.2	1.5

Note: Figures of 1976 production of the BEAs and BEA segments were used to calculate the future production of the BEA segments. Growth rates for the period 1976-2020 for each of the BEA segments were calculated by comparing the projected growth rates of the primary metal industry (measured by real earnings) of the BEAs with the projected growth rates of the production of nonferrous metals and alloys of the United States. Production by BEA during the period 2020-2040 was projected to increase at an average annual rate equal to half the rate projected for the period 2000-2020.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Production figures of 1976 from Table B-13. Projections from U.S. Department of the Interior, Bureau of Mines, Mineral Commodity Profiles, 1977-78 eds.; U.S. Department of the Interior, Bureau of Mines, Mineral Trends and Forecasts, 1976 ed.; and U.S. Water Resources Council, OBERS Projections, 1972 ed., Vol. II.

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Table D-14. Ohio River Basin: Production of Selected Manufactured Products[a] by BEAs or BEA Segments,[b] Estimated Average 1974-76 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated average 1974-76	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1974-76-2000	2000-2040
Primary Study Areas	7,561.2	9,905.0	14,252.3	20,061.1	35,621.5	47,984.3	4.0	2.2
BEA 47: Huntsville, AL	108.9	147.7	221.8	324.4	612.1	847.7	4.47	2.43
BEA 48: Chattanooga, TN	394.6	552.8	882.2	1,327.2	2,570.2	3,669.3	4.97	2.58
BEA 49: Nashville, TN	525.6	731.9	1,198.4	1,822.3	3,518.2	5,026.5	5.10	2.57
BEA 50: Knoxville, TN	123.3	164.8	263.0	386.9	726.3	1,000.6	4.68	2.40
BEA 52: Huntington, WV	540.6	742.2	1,144.7	1,650.2	2,971.2	3,997.8	4.57	2.24
BEA 54: Louisville, KY	1,354.0	1,871.2	2,917.1	4,318.1	8,209.4	11,393.1	4.75	2.46
BEA 55: Evansville, IN	445.9	593.0	873.3	1,249.6	2,270.1	3,074.5	4.21	2.28
BEA 62: Cincinnati, OH	1,339.8	1,681.1	2,228.1	2,970.3	4,883.9	6,287.9	3.24	1.89
BEA 64: Columbus, OH	398.2	509.9	694.0	936.9	1,561.1	2,021.1	3.48	1.94
BEA 65: Clarksburg, WV	248.8	324.5	482.5	680.1	1,198.3	1,595.8	4.10	2.16
BEA 66: Pittsburgh, PA	2,039.5	2,522.7	3,245.2	4,241.4	6,802.4	8,652.9	2.97	1.80
BEA 115: Paducah, KY	42.0	63.2	102.0	153.7	298.3	417.1	5.33	2.53

Note: 1974-76 average production for each product category was multiplied by the appropriate industrial growth rate in earnings estimated by BEA in the OBERS projections to obtain 1980-2020 projections by BEAs and BEA segments. The annual growth rates from 2020 to 2040 were assumed to be equal to half the annual growth rates from 2000 to 2040.

a. Includes fabricated metal products, machinery products, electrical machinery products, and ships and boats.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: 1974-76 average annual production from Table B-14. Annual growth rates derived from U.S. Water Resources Council, OBERS Projections, Regional Economic Activity in the U.S., Series E, 1972 ed., Vol. II

Table D-15. Ohio River Basin: Production of Others, Nec., by Commodity Types and BEAs or BEA Segments[a], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	15,273.5	17,061.7	15,425.4	16,253.8	18,661.7	20,685.4	0.07	0.48
Petro, coal products	2,198.6	2,333.6	1,795.2	1,878.1	2,131.7	2,577.2	(1.44)	0.25
Slag, iron and steel	9,424.9	10,865.4	9,767.5	10,513.0	12,667.3	14,245.5	0.26	0.65
Waterway improvement materials	3,650.0	3,862.7	3,862.7	3,862.7	3,862.7	3,862.7	0.41	0.09
BEA 47: Huntsville, AL	--	--	--	--	--	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	--	--	--	--	--	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV.	1,295.5	1,554.4	1,701.7	1,934.9	2,506.5	2,913.5	1.97	1.27
Petro, coal products	318.9	365.0	379.2	405.8	464.0	542.6	1.24	0.83
Slag, iron and steel	976.6	1,189.4	1,322.5	1,529.1	2,042.5	2,370.9	2.19	1.40
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 54: Louisville, KY	16.6	19.3	27.3	25.6	19.7	11.7	3.62	(0.55)
Petro, coal products	16.0	18.7	26.7	25.0	19.1	11.1	3.73	(0.57)
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	0.6	0.6	0.6	0.6	0.6	0.6	0.00	0.00
BEA 55: Evansville, IN	22.5	25.2	33.8	36.7	42.4	43.5	2.95	1.04
Petro, coal products	12.2	12.3	17.4	16.2	12.5	7.3	2.57	(0.80)
Slag, iron and steel	10.3	12.9	16.4	20.5	29.9	36.2	3.38	1.98
Waterway improvement materials	--	--	--	--	--	--	--	--

(Continued)

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Table D-15. (Continued)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-90	1976 -2040
BEA 62: Cincinnati, OH	1,237.5	1,408.8	1,167.4	1,298.7	1,666.0	1,915.4	(0.42)	0.68
Petro, coal products	238.3	225.5	191.3	201.9	240.9	290.5	(1.56)	0.31
Slag, iron and steel	999.2	1,183.3	976.1	1,096.8	1,425.1	1,624.9	(0.17)	0.76
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 64: Columbus, OH	2.9	6.0	2.0	1.9	1.5	0.9	(2.62)	(1.81)
Petro, coal products	2.9	6.0	2.0	1.9	1.5	0.9	(2.62)	(1.81)
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 66: Pitsburgh, PA	9,053.9	10,191.1	8,636.3	9,099.1	10,568.7	11,943.5	(0.34)	0.43
Petro, coal products	1,610.3	1,706.1	1,178.6	1,227.3	1,393.7	1,724.8	(2.20)	0.11
Slag, iron and steel	7,438.8	8,479.8	7,452.5	7,866.6	9,169.8	10,213.5	0.01	0.50
Waterway improvement materials	4.8	5.2	5.2	5.2	5.2	5.2	0.57	0.13
BEA 115: Paducah, KY	3,644.6	3,856.9	3,856.9	3,856.9	3,856.9	3,856.9	0.41	0.09
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	3,644.6	3,856.9	3,856.9	3,856.9	3,856.9	3,856.9	0.41	0.09

Note: Petroleum and coal products, nec.. consist of petroleum products and coal products. Petroleum products include wax and miscellaneous petroleum products, and coal products include coke oven gas, tar, crude light oil and coke oven ammonia. Slags include iron slags and steel slags. Waterway improvement materials primarily include rip-rap limestone produced to meet specific COE needs.

Production of petroleum products, nec., was projected by multiplying the average tons of petroleum products produced per ton of crude oil consumed in the U.S. in 1974-76 by the projected crude oil consumption in the BEAs provided in Commodity Group III Report (Crude Petroleum). Production of coal products was computed from the projected coal consumed in coke plants in the BEAs, based on the estimates that a ton of coal consumed would yield 0.123 ton of coal products which are not consumed in the producing plants themselves.

Production of iron slag was projected by applying a factor of 0.3125 tons of slag produced in blast furnaces per ton of pig iron produced to the RRNA projection of pig iron production by BEA, provided in Commodity Group VIII Report (Iron Ore, Iron and Steel). Production of steel slags is computed by applying the ratios of 250 lbs. of slag per tons of steel produced by open hearth and basic oxygen furnaces, and 150 lbs. of slag per ton of steel produced by electric arc furnace to the BEAs' iron and steel production projected in Group VIII report.

Production of waterway improvement materials in 1980 was projected base on the weighted average of growth rates of consumption in appropriate river and BEA destination. Production is later years was assumed to approximate the 1980 level.

a. Segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Table B-15, Drake, H.J. and J.E. Shelton, "Disposal of and Steel Slag", Proceedings of the Fourth Mineral Waste Utilization Symposium, Chicago, IL, May 1974; U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1975 ed., pp. 505-07; Coal (Group I), Crude Petroleum (Group III), and Iron Ore, Steel and Iron (Group VIII) Reports; and Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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APPENDIX E

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Table E-1. Ohio River Basin: Coal Consumption by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-1990	1976-2040
Primary Study Areas	194,578.4	216,792.8	268,856.5	334,826.2	465,251.4	606,624.0	1.79	1.75
Electric utilities	161,953.2	180,779.4	229,820.8	284,983.7	397,122.8	516,516.3		
Coke plants	16,880.1	17,885.9	12,766.6	13,576.5	15,929.8	20,136.7		
Others	15,745.1	18,127.5	26,269.1	36,266.0	52,198.8	69,971.0		
BEA 47: Huntsville, AL	3,356.6	3,050.1	2,246.4	1,919.3	1,732.1	1,018.2	(2.83)	(1.85)
Electric utilities[b]	3,181.6	2,839.0	1,909.0	1,475.0	1,027.8	--		
Coke plants	--	--	--	--	--	--		
Others	175.0	211.1	337.4	443.3	704.3	1,018.2		
BEA 48: Chattanooga, TN	5,511.9	5,576.7	2,888.9	2,638.7	2,307.2	2,122.4	(4.51)	(1.48)
Electric utilities[b]	4,972.4	4,940.0	1,974.0	1,459.0	762.1	--		
Coke plants	131.2	144.5	128.3	137.9	--	--		
Others	408.3	492.2	786.6	1,041.8	1,545.1	2,122.4		
BEA 49: Nashville, TN	11,102.3	13,963.0	11,674.4	9,146.2	10,174.1	4,583.1	0.36	(1.37)
Electric utilities[b]	10,279.9	12,971.0	10,089.0	7,000.0	6,902.7	--		
Coke plants	--	--	--	--	--	--		
Others	822.4	992.0	1,585.4	2,146.2	3,271.4	4,583.1		
BEA 50: Knoxville, TN	7,476.9	6,900.1	5,887.6	4,033.6	2,030.4	2,745.5	(1.69)	(1.55)
Electric utilities[b]	6,923.1	6,232.1	4,820.0	2,640.1	--	--		
Coke plants	--	--	--	--	--	--		
Others	553.8	668.0	1,067.6	1,393.5	2,030.4	2,745.5		
BEA 51: Bristol, VA	5,132.4	5,178.7	4,917.6	9,358.0	12,908.2	17,698.2	(0.30)	1.95
Electric utilities	4,383.5	4,393.1	4,417.3	8,634.3	11,837.1	16,229.8		
Coke plants	282.3	309.6	--	--	--	--		
Others	466.6	476.0	500.3	723.7	1,071.1	1,468.4		

(Continued)

Table E-1. (Continued)

BEA or BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-1990	1976-2040
BEA 52: Huntington, WV	34,708.9	36,896.2	42,010.8	51,514.9	69,223.2	87,911.6	1.37	1.46
Electric utilities	29,683.4	31,533.7	36,679.8	44,844.2	60,279.7	76,370.0		
Coke plants	1,828.3	2,100.9	1,902.6	2,195.0	2,927.3	3,919.5		
Others	3,197.2	3,261.6	3,428.4	4,475.7	6,016.2	7,622.1		
BEA 53: Lexington, KY	2,909.3	3,362.5	4,832.2	6,498.2	9,675.0	13,316.1	3.69	2.41
Electric utilities	2,669.1	3,072.7	4,369.1	5,820.6	8,666.1	11,927.6		
Coke plants	--	--	--	--	--	--		
Others	240.2	289.8	463.1	677.6	1,008.9	1,388.5		
BEA 54: Louisville, KY	11,134.9	13,089.0	19,623.0	26,626.5	40,427.8	56,525.6	4.13	2.57
Electric utilities	10,215.5	11,962.9	17,753.5	23,859.2	36,226.1	50,650.8		
Coke plants	--	--	--	--	--	--		
Others	919.4	1,126.1	1,869.5	2,767.3	4,201.7	5,874.8		
BEA 55: Evansville, IN	17,665.4	21,617.9	35,812.7	46,811.9	68,075.5	92,049.8	5.18	2.61
Electric utilities	16,206.8	19,831.4	32,846.8	42,624.5	61,985.6	83,815.2		
Coke plants	--	--	--	--	--	--		
Others	1,458.6	1,786.5	2,965.9	4,187.4	6,089.9	8,234.6		
BEA 62: Cincinnati, OH	20,969.5	25,069.2	39,727.6	51,691.7	74,252.8	99,347.0	4.67	2.46
Electric utilities	16,957.9	20,658.2	33,836.9	43,781.2	63,045.7	84,412.9		
Coke plants	1,707.2	1,588.6	1,205.6	1,314.5	1,708.7	2,216.6		
Others	2,304.4	2,822.4	4,685.1	6,596.0	9,498.4	12,717.5		
BEA 64: Columbus, OH	6,347.4	7,542.9	11,625.5	15,724.5	23,503.6	32,413.0	4.42	2.58
Electric utilities	5,667.3	6,697.3	10,167.3	13,584.6	20,305.1	28,002.0		
Coke plants	--	--	--	--	--	--		
Others	680.1	845.6	1,458.2	2,139.9	3,198.5	4,411.0		
BEA 65: Clarksburg, WV	5,321.5	5,863.3	7,492.1	9,645.3	13,809.2	18,416.6	2.47	1.96
Electric utilities	4,837.7	5,369.7	6,973.3	8,926.4	12,778.6	17,042.2		
Coke plants	--	--	--	--	--	--		
Others	483.8	493.6	518.8	718.9	1,030.6	1,374.4		

(Continued)

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Table E-1. (Continued)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-1990	1976-2040
BEA 66: Pittsburgh, PA	54,629.4	60,187.9	70,225.6	86,263.9	118,324.6	153,127.9	1.81	1.62
Electric utilities	38,170.3	42,428.3	55,270.3	69,043.8	96,916.5	125,979.9		
Coke plants	12,931.1	13,742.3	9,530.1	9,929.1	11,293.8	14,000.6		
Others	3,528.0	4,017.3	5,425.2	7,291.0	10,114.3	13,147.4		
BEA 68: Cleveland, OH	--	--	750.0	955.4	1,359.7	1,802.7	c	c
Electric utilities	--	--	750.0	955.4	1,359.7	1,802.7		
Coke plants	--	--	--	--	--	--		
Others	--	--	--	--	--	--		
BEA 115: Paducah, KY	8,312.0	8,495.3	9,142.1	11,998.1	17,448.0	23,546.3	0.68	1.64
Electric utilities	7,804.7	7,850.0	7,964.5	10,335.4	15,030.0	20,283.2		
Coke plants	--	--	--	--	--	--		
Others	507.3	645.3	1,177.6	1,662.7	2,418.0	3,263.1		

Note: Except where tonnages for 1990 electric utility consumption were derived from Department of Energy (DOE) regional projections of coal consumption by end user, 1990 consumption was based on the distribution of earlier DOE projections of coal consumption by electric utilities by BEA estimated by the Oak Ridge Laboratory, and adjusted to reflect plans of electric utilities in the PSAs as ascertained by a RRNA survey of utilities. When a BEA is located in more than one DOE region, an average share of relevant regions was employed. The 1980 tonnages were estimated through interpolation of 1976 and 1990 data. Electric utility consumption for 1990-2020 were assumed to grow at 75 percent of the BEA growth rates in personal income for 1990-2000 and 2000-2020. For the period 2020-2040, this consumption was assumed to increase at 50 percent of the BEA growth rates in personal income. BEA growth rates were obtained from OBERS Projections. Tonnages for use in coke manufacture in BEAs 52, 62, and 66 were projected using projections of pig iron production contained in the Iron Ore, Steel and Iron (Group VIII) Report, and estimates of coal requirements to produce pig iron. Factors of 0.55 tons of coke per ton of pig iron and 0.7 tons of coke produced per ton of coal carbonized were used for 1980 projections. Thereafter, factors of 0.45 and 0.7, respectively, were used. Other BEAs with coke consumption were assumed to grow at the same rate as BEAs 52, 62, and 66. The one beehive coke plant in BEA 51 was assumed to shutdown during the 1981-1990 period. All small producers of coke were assumed to shutdown in 2000. Tonnages of other consumption were based on regional DOE projections of growth rates of non-metallurgical industrial use, and disaggregated and projected in a similar manner as electric utility consumption.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

b. Tonnages for electric utility plant consumption for 1980-90 based on information obtained from surveys of projected TVA steam plant coal consumption, and correspondence from TVA, Fossil Fuels Planning Branch, Chattanooga, Tennessee. Consumption after 1990 based on assumptions that the Watts Bar, Widdows Creek, and Colbert Steam Plants will continue its coal consumption trend through 2020 and will shut down in 2020-2040, and that the Bull Run and Kingston Plants will follow their trends through 1976-2000 and will shutdown between 2000 and 2020.

c. No production in 1976.

Source: Table C-1 and U.S. Department of Energy, "Appendix," Annual Report to Congress, Vol. II, 1977 ed.; Oak Ridge National Laboratory, Energy Availabilities for State and Local Development, 1978; U.S. Water Resources Council, OBERS Projections, Economic Activity in the United States, Series E, 1972 ed. Correspondence from TVA, Fossil Fuels Planning Branch, Chattanooga, Tennessee, and selected Ohio River Basin Users Survey Questionnaires, provided by the U.S. Army Corps of Engineers.

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Table E-2. Ohio River Basin: Consumption of Petroleum Fuels by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	47,592.3	48,895.8	59,621.3	64,826.8	54,249.7	38,188.3	1.62	(0.34)
BEA 47: Huntsville, AL	2,276.5	2,328.9	2,909.3	3,101.9	2,593.2	1,810.0	1.77	(0.36)
BEA 48: Chattanooga, TN	2,420.1	2,582.4	3,178.9	3,395.7	2,838.8	1,981.5	1.97	(0.31)
BEA 49: Nashville, TN	4,529.6	4,813.3	5,948.4	6,417.1	5,364.7	3,744.6	1.97	(0.30)
BEA 50: Knoxville, TN	2,867.7	3,019.6	3,602.3	3,875.4	3,293.8	2,261.4	1.64	(0.37)
BEA 52: Huntington, WV	3,517.5	3,312.0	3,687.6	4,013.6	3,355.4	2,342.1	0.34	(0.63)
BEA 53: Lexington, KY	2,204.2	2,227.3	2,693.8	2,837.1	2,371.8	1,655.5	1.44	(0.45)
BEA 54: Louisville, KY	3,662.5	3,846.2	4,753.2	5,165.8	4,318.6	3,014.4	1.88	(0.30)
BEA 55: Evansville, IN	2,485.9	2,691.8	3,284.5	3,611.6	3,019.3	2,107.5	2.01	(0.26)
BEA 62: Cincinnati, OH	5,210.0	5,479.3	6,581.7	7,126.7	5,957.9	4,518.6	1.68	(0.22)
BEA 64: Columbus, OH	4,634.4	4,806.8	6,397.5	6,996.3	5,848.9	4,082.5	2.33	(0.20)
BEA 65: Clarksburg, WV	629.1	574.9	672.5	728.2	608.8	424.9	0.48	(0.61)
BEA 66: Pittsburgh, PA	12,118.4	12,138.8	14,638.3	16,188.5	13,533.6	9,446.5	1.36	(0.39)
BEA 68: Cleveland, OH	336.8	335.8	394.7	425.9	356.1	248.5	1.14	(0.47)
BEA 115: Paducah, KY	699.6	738.7	878.6	943.0	788.4	550.3	1.64	(0.37)

Note: The consumption of petroleum fuels for 1980 is projected based on the annual growth rates of the BEAs for the 1974-80 period of the sum of gasoline, distillate and residual fuel oils, provided in the Oak Ridge report, adjusted for the latest projections made by the U.S. Department of Energy (DOE). The 1990 and 2000 projections are derived from the national consumption estimated by DOE and distributed to the BEAs by 1985 allocation factors provided by Oak Ridge. The rates of consumption change in the later decades are assumed to be two-thirds of the rates of change of petroleum fuel production.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Energy, Energy Information Administration, Annual Report to Congress, Vol. II, 1977 ed; Oak Ridge National Laboratory, Energy Availabilities for State and Local Development: Projected Energy Patterns for 1980 and 1985, June 1978; and Table C-2.

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Table E-3. Ohio River Basin: Consumption of Crude Petroleum by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-90	1976-2040
Primary Study Areas	1,880.2	2,663.1	2,015.1	1,844.1	1,441.3	838.8	.50	(1.25)
BEA 55: Evansville, IN	953.5	963.3	1,357.5	1,269.3	971.0	565.1	2.56	(0.81)
BEA 64: Columbus, OH	225.1	465.9	159.4	149.0	114.0	66.3	(2.44)	(1.89)
BEA 66: Pittsburgh, PA	701.6	1,233.9	498.2	465.8	356.3	207.4	(2.42)	(1.89)

Note: The consumption of crude petroleum for 1980 is based on the average annual growth rates of the BEAs for the 1974-80 period provided in the Oak Ridge report, adjusted for the latest projection (series C) made by the U.S. Department of Energy (DOE). The 1990 projections are derived from the national consumption estimated by DOE and distributed to the BEAs by 1985 allocation factors provided by Oak Ridge. In the long run, crude oil consumption is expected to be influenced by the declining domestic supply, and the rates of consumption change in the post-1990 decades are assumed to be two-thirds of the rates of change of crude oil production.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Energy, Energy Information Administration, Annual Report to Congress, Vol. II, 1977 ed.; Oak Ridge National Laboratory, Energy Availabilities for State and Local Development: Projected Energy Patterns for 1980 and 1985, June 1978; and Table C-3.

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Table E-4. Ohio River Basin: Consumption of Aggregates, by BEAs or BEA Segments[a], Estimated Average 1974-76 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated average 1974-76	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1974-76-2000	2000-2040
Primary Study Areas	132,691.8	139,680.5	161,785.4	178,855.8	211,523.6	229,685.8	1.2	0.6
BEA 47: Huntsville, AL	5,909.3	6,574.2	8,380.2	10,087.6	13,224.3	14,968.8	2.2	1.0
BEA 48: Chattanooga, TN	8,987.1	8,733.4	10,300.3	11,380.4	13,718.4	15,005.2	0.9	0.7
BEA 49: Nashville, TN	18,651.7	17,719.2	19,174.0	19,606.1	24,609.0	27,354.4	0.2	0.8
BEA 50: Knoxville, TN	9,024.0	9,164.2	9,578.9	9,546.5	10,769.9	11,430.1	0.2	0.5
BEA 52: Huntington, WV	9,778.8	9,776.6	10,708.8	11,408.6	11,582.0	11,655.4	0.6	0.1
BEA 53: Lexington, KY	6,773.7	7,005.1	7,190.3	6,958.9	8,176.8	8,836.9	0.1	0.6
BEA 54: Louisville, KY	14,802.2	15,408.2	17,168.6	18,241.8	23,046.2	25,704.4	0.8	0.9
BEA 55: Evansville, IN	7,130.7	7,383.9	7,741.5	7,849.2	9,239.9	9,998.6	0.4	0.6
BEA 62: Cincinnati, OH	16,184.2	19,306.2	24,203.6	28,354.3	34,632.5	38,318.3	2.3	0.8
BEA 64: Columbus, OH	2,463.4	2,632.9	3,464.7	4,308.8	5,353.4	5,925.9	2.3	0.8
BEA 65: Clarksburg, WV	1,876.4	1,903.4	2,227.6	2,502.3	2,733.2	2,854.9	1.2	0.3
BEA 66: Pittsburgh, PA	26,152.6	28,669.2	34,193.8	40,367.7	45,046.7	47,618.5	1.8	0.4
BEA 68: Cleveland, OH	1,417.7	1,479.3	1,817.1	2,170.5	2,561.5	2,774.6	1.7	0.6
BEA 115: Paducah, KY	3,540.0	3,924.7	5,636.0	6,073.1	6,829.8	7,239.8	2.2	0.4

Note: Consumption of flux by BEA and BEA segment was projected by applying ratio of flux per ton of iron and steel manufactures to RRNA projection of iron and steel production and furnace type. Consumption of crushed rocks by cement and lime industry by BEA segment was obtained by applying a factor of 1.8 and 2.0 respectively to RRNA projections of cement and lime production. Projected consumption of construction aggregates was obtained by projecting per capita consumption of aggregates by BEA segment and applied to projected population by BEA segment.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Table C-4; American Iron and Steel Institute: Annual Statistical Report, 1969 eds.; U.S. Department of Interior Bureau of Mines, Mineral Commodity Profile, "Stone," July 1978 and "Sand and Gravel," September 1978; Mineral Trends and Forecasts, 1979 ed. Mineral Facts and Problems, 1975 ed., and Mineral Yearbook, "Sand and Gravel," "Stone," 1972 ed.; U.S. Water Resources Council, OBERS Projections, Regional Activity in the U.S., Series E, 1972 ed., and unpublished data on tapes. Cement and lime and iron and steel projections from Group XII and Group VIII sections of this study.

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Table A-5. Ohio River Basin: Consumption of Grain[a], by BEAs or BEA Segments[b], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1974-76—2000	2000-2040
Primary Study Areas	22,081.5	22,352.2	23,323.4	25,139.0	26,104.0	27,102.8	0.54	0.19
BEA 44: Atlanta, GA	1,577.8	1,558.6	1,666.5	1,789.8	1,876.0	1,968.2	0.53	0.24
BEA 45: Birmingham, AL	1,272.9	1,234.0	1,305.0	1,521.1	1,600.9	1,686.8	0.74	0.26
BEA 46: Memphis, TN	310.9	353.1	389.0	427.8	445.9	463.8	1.34	0.20
BEA 47: Huntsville, AL	2,059.8	2,062.9	2,201.7	2,351.2	2,425.0	2,500.3	0.55	0.15
BEA 48: Chattanooga, TN	1,823.0	1,812.4	1,917.2	1,985.1	2,027.7	2,070.9	0.36	0.11
BEA 49: Nashville, TN	2,270.6	2,453.3	2,623.3	2,940.0	3,075.0	3,215.1	1.08	0.22
BEA 50: Knoxville, TN	326.7	339.5	354.7	372.1	393.3	414.2	0.54	0.27
BEA 52: Huntington, WV	256.2	276.7	268.7	297.7	284.2	284.5	0.63	(0.11)
BEA 53: Lexington, KY	1,177.8	1,233.0	1,291.6	1,415.6	1,512.1	1,609.0	0.77	0.32
BEA 54: Louisville, KY	1,778.6	1,747.3	1,818.1	1,955.7	2,063.8	2,173.4	0.40	0.26
BEA 55: Evansville, IN	2,550.5	2,428.6	2,576.3	2,873.2	3,037.2	3,206.4	0.50	0.27
BEA 56: Terre Haute, IN	83.4	144.5	148.7	159.3	164.6	169.9	2.73	0.16
BEA 60: Indianapolis, IN	1,760.8	1,776.9	1,829.1	1,926.2	1,977.9	2,032.9	0.37	0.13
BEA 61: Anderson, IN	164.8	156.3	153.5	156.1	153.8	150.1	(0.23)	(0.10)
BEA 62: Cincinnati, OH	1,202.3	1,234.4	1,239.7	1,356.9	1,401.1	1,447.2	0.13	0.16
BEA 63: Dayton, OH	1,602.7	1,719.6	1,674.5	1,671.3	1,670.4	1,672.0	0.17	0.00
BEA 64: Columbus, OH	539.1	595.7	569.6	569.6	570.3	572.5	0.23	0.01
BEA 114: St. Louis, MO	205.3	194.4	206.1	228.9	237.0	245.4	0.45	0.17
BEA 115: Paducah, KY	1,118.3	1,031.0	1,090.1	1,159.4	1,187.8	1,220.2	0.15	0.13

Note: Individual items may not add to total due to rounding. Data assembled on a county level and assembled into BEAs or BEA segments.

a. Total consumption of corn, wheat and soybeans only. Corn is corn for grain. Wheat is all wheat. Soybeans are soybeans for beans. Consumption of grain represents the addition of the consumption of corn, wheat and soybeans by livestock, processing and seed.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Agriculture, Economic Research Service, USDA National-Interregional Agricultural Projections (NIRAP) System, July 1978.

This source provides state level projections of livestock production, by livestock category, to 2000. Livestock numbers raised by each of the states of Alabama, Georgia, Illinois, Indiana, Kentucky, Mississippi, Ohio and Tennessee were averaged for 1974, 1975 and 1976 and represent base year livestock production. The base year level was subtracted from the 2000 projections. This difference was divided by two and reported as 2040. The difference between 2000 and 2040 was equally divided among the remaining years in ten year intervals. For each BEA and BEA segment, the percentage of the respective states' total livestock production (1969-1976) was estimated and was projected into the future using trend analysis, in conjunction with expert judgement. The percent of the state's total livestock production allocated to each BEA and BEA segment by period (1980 to 2040) was multiplied by the state totals to estimate livestock production by BEA and BEA segment. Livestock numbers were multiplied by the corn, wheat and soybean ration fed by category by state. Acres harvested were multiplied by seeding rates by state to estimate grain consumption by seed. Processing capacity was assumed to remain constant from 1976 with the exception of known expansions and new construction.

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Table E-6. Ohio River Basin: Consumption of Industrial and Agricultural Chemicals, by BEAs or BEA Segments,[a] Estimated Average 1974-76 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated average 1974-76	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1974-76--2000	2000-2040
Primary Study Areas	13,921.5	16,140.5	22,250.3	30,725.2	52,342.8	69,231.6	3.2	2.1
BEA 47: Huntsville, AL	805.8	1,024.0	1,656.4	2,492.7	4,727.7	6,594.6	4.6	2.5
BEA 48: Chattanooga, TN	1,146.1	1,478.2	2,195.3	3,157.6	5,722.3	7,747.6	4.1	2.3
BEA 49: Nashville, TN	1,158.8	1,315.7	1,822.7	2,507.4	4,134.5	5,394.1	3.1	1.9
BEA 50: Knoxville, TN	927.0	1,114.9	1,561.0	2,170.3	3,793.2	5,045.2	3.5	2.1
BEA 52: Huntington, WV	1,422.5	1,689.6	2,045.1	2,604.2	4,062.0	5,092.3	2.4	1.7
BEA 54: Louisville, KY	1,219.5	1,446.1	2,053.1	2,882.4	5,046.9	6,725.5	3.5	2.1
BEA 55: Evansville, IN	926.5	676.3	979.4	1,339.6	2,146.5	2,744.2	1.5	1.8
BEA 62: Cincinnati, OH	1,893.0	2,286.8	3,297.9	4,638.5	8,230.3	11,031.4	3.6	2.2
BEA 64: Columbus, OH	957.4	1,210.3	1,786.9	2,577.9	4,734.7	6,497.0	4.0	2.3
BEA 66: Pittsburgh, PA	2,885.0	3,246.4	3,907.4	5,018.8	7,501.3	9,400.3	2.2	1.6
BEA 68: Cleveland, OH	37.4	38.6	49.0	60.6	91.2	114.5	1.9	1.6
BEA 115: Paducah, KY	542.5	613.1	896.1	1,275.2	2,152.2	2,844.9	3.5	2.0

Note: Industrial chemical consumption for the period 1980-2040 was estimated using the 1974-76 annual average of industrial chemical consumption, by BEA and BEA segment and consuming industry, and growth rates by BEA of these consuming industries (chemical and allied products, textile products, paper and allied products, petroleum refining products, primary metal products, and miscellaneous manufacturing products). Growth rates for the period 1980-2020 were obtained from OBERS Projections. Annual growth rates for the period 2020-2040 were assumed equal to half the annual growth rate projected for the period 2000-2020. Agricultural chemical consumption was derived by the multiplication of fertilizer application rates (in N, P_2O_5, and K_2O primary nutrient units) for corn, wheat and soybeans by the percent of harvested acres receiving fertilizer times a factor for acres planted and fertilized but not harvested by the tons of fertilizer material necessary to provide 1 ton of primary nutrient. Fertilizer material tons were derived by dividing the estimated domestic supply of N, P_2O_5 and K_2O chemical materials by the average analysis (i.e. the percentage of primary nutrient contained per unit of chemical material). Fertilizer material tons, application rates and, percent of acres fertilized assumed constant after 1990.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: The 1974-76 annual average of consumption from Table C-6. Average annual growth rates were derived from U.S. Water Resources Council, OBERS Projections, Regional Economic Activity in the U.S., Series E, 1972 ed. Nitrogenous, potassic and phosphatic chemical fertilizer material estimated future supply from Tennessee Valley Authority, Economics and Marketing Research Section: World Fertilizer Capacity, February 1979. Projected fertilizer application rates and percent of acres fertilized from Fertilizer Institute, Third World Fertilizer Conference Proceedings, "Musings on the U.S. Fertilizer Industry, 1990" (Remarks of Dr. John Douglas, Assistant to the Manager, Tenessee Valley Authority), September 1978. Projected acres harvested by BEA and BEA segment derived from Grains (Group V) Report.

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Table E-7. Ohio River Basin: Consumption of Ores and Minerals,[a] by BEAs or BEA Segments,[b] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-2000	2000-2040
Primary Study Areas	6,720.2	8,289.3	13,503.2	18,987.9	33,076.4	45,664.3	4.4	2.2
BEA 47: Huntsville, AL	618.1	793.3	1,492.9	2,215.3	4,085.2	5,796.2	5.5	2.4
BEA 48: Chattanooga, TN	345.8	403.9	712.3	1,020.4	1,804.6	2,491.2	4.6	2.3
BEA 49: Nashville, TN	380.6	494.1	953.7	1,407.3	2,585.4	3,580.0	5.6	2.4
BEA 50: Knoxville, TN	657.5	831.0	1,398.5	1,957.2	3,361.7	4,470.0	4.7	2.1
BEA 52: Huntington, WV	437.4	544.6	809.7	1,076.9	1,731.8	2,471.3	3.8	2.1
BEA 54: Louisville, KY	180.7	212.0	285.3	358.9	523.1	784.8	2.9	2.0
BEA 55: Evansville, IN	1,118.9	1,709.9	3,916.2	6,212.0	12,347.8	17,515.1	7.4	2.6
BEA 62: Cincinnati, OH	235.3	276.2	377.1	473.5	685.2	1,029.9	3.0	2.0
BEA 64: Columbus, OH	500.4	549.3	653.0	801.5	1,159.2	1,590.5	2.0	1.7
BEA 65: Clarksburgh, WV	48.9	55.6	70.0	80.7	99.6	122.1	2.1	1.0
BEA 66: Pittsburgh, PA	1,916.8	2,094.8	2,418.5	2,851.4	3,887.9	4,754.3	1.7	1.3
BEA 68: Cleveland, OH	1.0	1.1	1.5	2.0	3.3	5.7	2.9	2.7
BEA 115: Paducah, KY	278.8	323.5	414.5	530.8	801.6	1,053.2	2.7	1.7

a. Includes consumption of manganese, liquid sulfur, rock salt, zinc ore and alumina.
b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.
Source: Consumption of manganese, liquid sulfur, rock salt, zinc ore and alumina from Tables 11-15, respectively of Group VII Report.

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Table E-8. Ohio River Basin: Consumption of Iron Ore, Iron and Steel Products by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	89,416.1	100,662.6	101,286.0	116,005.2	155,314.8	183,544.2	1.1	1.1
BEA 47: Huntsville, AL	43.1	55.3	84.0	123.9	236.2	326.9	4.5	2.5
BEA 48: Chattanooga, TN	936.7	1,177.2	1,613.1	2,156.0	3,581.0	4,672.1	3.4	2.0
BEA 49: Nashville, TN	532.8	707.7	1,154.2	1,754.0	3,454.9	4,869.9	5.1	2.6
BEA 50: Knoxville, TN	439.4	527.4	687.1	894.8	1,440.8	1,851.2	3.0	1.8
BEA 52: Huntington, WV	6,457.8	7,880.5	8,947.4	10,638.8	14,613.0	17,242.9	2.6	1.2
BEA 54: Louisville, KY	1,064.2	1,390.2	2,204.9	3,311.2	6,425.0	8,983.3	4.8	2.5
BEA 55: Evansville, IN	536.4	675.0	961.7	1,339.8	2,347.4	3,123.8	3.7	2.1
BEA 62: Cincinnati, OH	8,744.5	10,415.9	10,725.7	12,663.0	17,887.8	21,394.4	1.6	1.3
BEA 64: Columbus, OH	133.1	162.5	222.3	303.1	508.4	659.5	3.5	2.0
BEA 66: Pittsburgh, PA	53,704.5	61,401.4	58,791.7	64,130.1	79,040.1	90,153.0	0.8	0.8
BEA 67: Youngstown, PA	16,823.6	16,269.9	15,893.9	18,690.5	25,780.2	30,267.2	0.4	1.2

Note: Consumption of iron ore, iron and steel products was projected for 1980-2040 on an individual commodity basis. Consumption totals shown include iron ore consumption from Table A-7, pig iron consumption from Table A-8 and steel consumption from Table A-9, iron and steel scrap consumption from Table A-12 ferroalloy consumption from Table A-10 and foundry consumption from Table A-11.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Consumption of the iron ore, iron and steel commodity group shown in Tables A-7 through A-12 for 1976, 1980, 1990, 2000, 2020 and 2040, respectively, of Group VIII Report.

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Table E-9. Ohio River Basin: Consumption of Food and Feed Products, by BEAs or BEA Segments,[a] Estimated Average 1974-76 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated average 1974-76	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1974-76—2000	2000-2040
Primary Study Areas	4,868.8	5,218.0	6,075.6	7,155.5	9,420.7	10,930.6	1.55	1.06
BEA 47: Huntsville, AL	456.2	492.2	607.3	737.3	1,024.1	1,225.0	1.94	1.28
BEA 48: Chattanooga, TN	502.8	558.9	675.6	796.5	1,053.9	1,220.8	1.86	1.07
BEA 49: Nashville, TN	960.0	1,052.2	1,251.3	1,497.1	1,968.5	2,289.9	1.79	1.07
BEA 50: Knoxville, TN	346.8	385.8	463.9	556.6	775.0	919.6	1.91	1.26
BEA 54: Louisville, KY	736.0	801.8	909.7	1,057.2	1,381.7	1,595.9	1.46	1.03
BEA 55: Evansville, IN	670.9	614.4	680.1	784.3	947.9	1,062.3	0.63	0.76
BEA 62: Cincinnati, OH	727.2	807.2	932.8	1,101.4	1,474.7	1,719.1	1.67	1.12
BEA 66: Pittsburgh, PA	468.9	505.5	555.0	625.2	794.9	898.1	1.16	0.91

Note: Individual items may not add to total due to rounding. The 1974-76 three year average of estimated industrial consumption of food and feed products (i.e., wheat flour, sugar and corn and soybean oil) was projected for 1980-2040 using the growth rate of earnings in the food and kindred products industry as projected by U.S. Department of Commerce, OBERS Projections. The 1974-76 three year average of estimated livestock consumption of food and feed products (i.e., prepared animal feed and grain mill products, nec.) was projected for 1980-2040 using the growth rate of corn consumption by livestock by BEA and BEA segment projected for Grains (Group V) Report. Projected livestock corn consumption in tons by BEA and BEA segment was multiplied by a factor of .234 tons which represents the amount of prepared animal feed and grain products, nec. consumed per ton of corn consumed.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Consumption of food and feed products by BEA and BEA segment for 1974-76 from Table C-9. Average annual growth rates for industrial consumption were derived from U.S. Water Resources Council, OBERS Projection, Regional Economic Activity in the U.S., Series E, 1972 ed., Vol. II.

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Table E-10. Ohio River Basin: Consumption of Wood and Paper Products, by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated	Projected					Average annual percentage and change	
	1976[b]	1980[c]	1990[c]	2000[c]	2020[c]	2040[d]	1976-1990	1976-2040
Primary Study Areas	13,247.5	15,811.4	22,971.2	29,984.7	45,873.4	58,779.1	4.01	2.36
BEA 47: Huntsville, AL	3,605.3	4,778.1	7,566.2	10,342.6	15,289.2	19,085.4	5.44	2.64
BEA 48: Chattanooga, TN	2,787.7	3,045.0	3,859.0	4,681.7	6,595.2	8,027.0	2.35	1.67
BEA 50: Knoxville, TN	2,416.7	2,959.8	5,063.2	7,171.9	12,143.8	16,395.4	5.42	3.04
BEA 54: Louisville, KY	974.6	1,106.8	1,400.7	1,667.0	2,549.1	3,337.2	2.62	1.94
BEA 62: Cincinnati, OH	2,244.1	2,507.6	3,204.2	3,822.8	5,655.6	7,118.4	2.58	1.82
BEA 66: Pittsburgh, PA	1,074.2	1,247.2	1,680.8	2,076.6	3,348.0	4,454.9	3.25	2.25
BEA 115: Paducah, KY	144.9	166.9	197.1	222.1	292.5	360.8	2.22	1.44

a. BEA segments defined as counties which are ultimate origins or destinations or waterborne movements.
b. Estimated 1976 consumption from Table C-10. Wood and paper products include pulpwood logs, lumber products and paper products.
c. Consumption of lumber products based on OBERS growth rates of earnings in lumber product and furniture industries, by BEA, adjusted by the U.S. ratio of earnings to consumption in the industries. Consumption of pulpwood log and paper products are projected by the same method, using the growth rates of earnings in the paper products industry and earnings in the printing and publishing industries, respectively.
d. Rates of growth in the consumption of wood and paper products commodities for 2020-2040 are assumed to equal one-half of growth rates between 2000-2020.
Source: U.S. Water Resources Council, 1972 OBERS Projections, Volumes 1 and 2; U.S. Department of Commerce, Bureau of Domestic Commerce, data on file; U.S. Department of Agriculture, Forest Service, The Nation's Renewable Resources--An Assessment, 1975 ed.

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Table E-11. Ohio River Basin: Consumption of Petroleum Products, Nec., by BEAs or BEA Segments,[a] Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	2,883.7	3,326.2	4,682.1	5,308.6	4,442.1	3,126.8	3.83	0.13
BEA 47: Huntsville, AL	158.6	162.7	251.2	273.3	228.7	161.0	3.34	0.02
BEA 48: Chattanooga, TN	166.8	161.8	246.0	267.4	223.7	157.5	2.81	(0.09)
BEA 49: Nashville, TN	345.1	381.4	604.9	657.6	550.3	387.3	4.09	0.18
BEA 50: Knoxville, TN	165.9	243.7	352.8	383.6	321.0	226.0	5.54	0.48
BEA 52: Huntington, WV	240.4	238.0	326.7	355.5	297.5	209.4	2.22	(0.22)
BEA 54: Louisville, KY	300.3	277.7	426.3	463.4	387.7	272.9	2.53	(0.15)
BEA 62: Cincinnati, OH	617.3	739.2	1,110.1	1,207.3	1,010.2	711.1	4.28	0.22
BEA 64: Columbus, OH	159.2	163.9	246.6	267.9	224.2	157.8	3.18	(0.01)
BEA 66: Pittsburgh, PA	619.8	855.2	1,171.8	1,274.4	1,066.4	750.6	4.65	0.30
BEA 68: Cleveland, OH	44.6	44.5	61.9	67.1	56.2	39.5	2.37	(0.19)
BEA 115: Paducah, KY	65.7	58.1	83.8	91.1	76.2	53.7	1.75	(0.31)

Note: The 1980 projections were estimated by computing the average annual growth rates of consumption of "other hydrocarbons" for the 1974-80 period for each BEA in the Oak Ridge Report and by assuming that the growth rates of BEA segments consumption are the same as those of the whole BEAs. Estimates for 1990 were derived by the same methods, extending the 1980-85 average annual growth rates of the BEAs to cover the 1980-90 period. For the post 1990 years, the consumption of petroleum products for the ORB as a region is assumed to grow at the same rate as the consumption of petroleum fuels. Allocation of ORB consumption to BEA segments is based on the 1985 distribution ratios.

a. Segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: U.S. Department of Energy, Energy Information Administration, Annual Report to Congress, Vol. II, 1977 ed.; Oak Ridge National Laboratory, Energy Availabilities for State and Local Development: Projected Energy Patterns for 1980 and 1985, June 1978; and Petroleum Fuels (Group II) Report.

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Table E-12. Ohio River Basin: Consumption of Lime and Portland Cement, by BEAs or BEA Segments,[a] Estimated Average 1974-76, and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated Average 1974-76	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1974-76—2000	2000-2040
Primary Study Areas	7,270.7	11,429.5	16,677.5	19,942.2	25,044.2	28,511.0	4.1	0.9
BEA 47: Huntsville, AL	398.5	471.4	712.4	974.8	1,588.0	2,075.3	3.6	1.9
BEA 49: Nashville, TN	521.3	558.3	789.4	1,031.0	1,229.7	1,345.9	2.8	0.7
BEA 50: Knoxville, TN	267.1	285.0	376.7	464.2	521.1	557.7	2.2	0.5
BEA 52: Huntington, WV	841.9	1,060.1	1,255.0	1,513.1	2,002.4	2,345.9	2.4	1.1
BEA 54: Louisville, KY	588.6	2,890.6	4,801.4	5,195.5	5,974.6	6,408.6	9.1	0.5
BEA 55: Evansville, IN	254.1	305.9	410.0	529.8	765.6	935.0	3.0	1.4
BEA 62: Cincinnati, OH	1,088.1	1,428.0	2,174.5	2,853.7	4,165.5	5,101.9	3.9	1.5
BEA 64: Columbus, OH	513.7	804.6	1,237.9	1,629.1	2,554.6	3,223.4	4.7	1.7
BEA 65: Clarksburg, WV	88.3	95.5	120.3	143.7	157.0	166.7	2.0	0.4
BEA 66: Pittsburgh, PA	2,554.9	3,348.3	4,507.0	5,241.9	5,634.0	5,843.9	2.9	0.3
BEA 68: Cleveland, OH	57.6	64.0	88.7	115.7	129.9	138.2	2.8	0.5
BEA 115: Paducah, KY	96.6	118.0	204.2	255.7	321.8	368.8	4.0	0.9

Note: Projected consumption of portland cement was derived from estimated state per capita consumption in future years and projected county population. Projected consumption of lime by the steel industry derived from lime usage per ton of steel produced by furnace type and projections of steel production by BEA and BEA segment. Projected consumption of lime by the chemical industry was estimated from RRNA projection of production by the chemical industry. Projected consumption of lime by desulphurization use estimated for planned lime/limestone flue gas desulphurization (FGD) installations processes.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Estimated from U.S. Environmental Protection Agency, Flue Gas Desulphurization in Power Plants Status Report, April 1977; from U.S. Water Resources Council, 1972 OBERS Projection, Regional Economic Activity in the U.S.; from American Iron and Steel Institute, Annual Statistical Report, 1976; and from the Iron Ore, Steel and Iron (Group VIII) Report and Chemicals and Chemical Fertilizers (Group VI) Report.

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Table E-13. Ohio River Basin: [a] Consumption of Nonferrous Metals and Alloys, by BEAs or BEA Segments, [a] Estimated 1976 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA or BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-2000	2000-2040
Primary Study Areas	1,464.9	1,814.0	2,681.2	3,575.9	6,050.3	7,893.2	3.8	2.0
BEA 48: Chattanooga, TN	109.8	143.5	232.0	320.7	567.0	756.2	4.6	2.2
BEA 49: Nashville, TN	188.4	242.6	406.2	576.3	1,057.2	1,435.2	4.8	2.3
BEA 50: Knoxville, TN	29.6	36.8	57.4	78.0	135.5	178.9	4.1	2.1
BEA 52: Huntington, WV	229.2	269.4	360.3	456.7	711.3	888.8	2.9	1.7
BEA 55: Evansville, IN	230.1	290.4	442.8	596.8	1,036.8	1,369.2	4.1	2.1
BEA 62: Cincinnati, OH	199.0	251.1	378.2	509.8	868.6	1,135.8	4.0	2.0
BEA 66: Pittsburgh, PA	478.8	580.2	804.3	1,037.6	1,673.9	2,129.1	3.3	1.8

Note: Figures of 1976 consumption of the BEA segments were used to calculate the future consumption of the BEA segments. Growth rates for the period 1976-2020 for each of the BEA segments were calculated by comparing the projected growth rates of total earnings of the BEAs with the projected growth rates of the consumption of nonferrous metal and alloys of the United States. Consumption by BEA during the period 2020-2040 was projected to increase at an average annual growth rate equal to half the rate projected for the period 2000-2020.

a. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Sources: Consumption figures of 1976 from Table C-13. Projections from U.S. Department of the Interior, Bureau of Mines, Mineral Commodity Profiles, 1978 ed.; U.S. Department of the Interior, Bureau of Mines, Mineral Facts and Problems, 1975 ed.; U.S. Water Resources Council, OBERS Projections, 1972 ed., Vol. II.

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Table E-14 Ohio River Basin: Consumption of Selected Manufactured Products,[a] by BEAs or BEA Segments,[b] Estimated Average 1974-76 and Projected 1980-2040

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated average 1974-76	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1974-76—2000	2000-2040
Primary Study Areas	5,976.0	7,393.1	10,419.7	14,653.7	26,469.2	35,925.7	3.7	2.3
BEA 47: Huntsville, AL	282.7	359.1	557.7	841.5	1,740.3	2,535.8	4.5	2.8
BEA 48: Chattanooga, TN	342.8	441.7	653.8	940.2	1,731.4	2,378.3	4.1	2.3
BEA 49: Nashville, TN	687.8	873.7	1,331.1	1,970.3	3,771.7	5,283.8	4.3	2.5
BEA 50: Knoxville, TN	293.7	360.8	518.9	732.0	1,322.1	1,780.7	3.7	2.2
BEA 52: Huntington, WV	438.1	510.3	646.9	844.4	1,356.9	1,722.5	2.7	1.8
BEA 54: Louisville, KY	578.3	738.1	1,103.1	1,617.2	3,095.8	4,337.0	4.2	2.5
BEA 55: Evansville, IN	393.8	490.7	692.2	967.0	1,746.5	2,352.3	3.7	2.2
BEA 62: Cincinnati, OH	1,243.6	1,549.8	2,165.1	3,024.7	5,357.8	7,216.2	3.6	2.2
BEA 64: Columbus, OH	162.2	207.0	303.5	440.7	827.4	1,136.6	4.1	2.4
BEA 65: Clarksburg, WV	84.6	100.5	137.7	190.5	337.4	454.4	3.3	2.2
BEA 66: Pittsburgh, PA	1,385.4	1,661.4	2,168.6	2,886.2	4,822.5	6,244.0	3.0	1.9
BEA 115: Paducah, KY	83.0	100.0	141.1	199.0	359.4	484.1	3.6	2.2

Note: Estimates of 1980-2020 consumption were derived from average annual growth rates by BEA of total earnings applied to actual average 1974-76 consumption. 2040 estimates were derived using growth rates for the period 2020-2040 equal to half the projected growth rate for the period 2000-2020.

a. Includes fabricated metal products, machinery products, electrical machinery products and ships and boats.

b. BEA segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Estimated average 1974-76 consumption from Table C-14. Projections estimated from growth rates by BEA from U.S. Water Resources Council, OBERS Projections, Regional Economic Activity in the U.S., Series E, 1972 ed., Vol. II.

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Table E-15 Ohio River Basin: Consumption of Others, Nec., by BEA or BEA Segments[a], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	5,373.9	5,922.4	6,051.5	6,557.3	7,615.9	8,169.5	0.85	0.66
Petro, coal products	2,803.4	3,245.8	3,579.4	3,946.5	4,594.5	4,847.6	1.76	0.86
Slag, iron and steel	2,000.0	2,064.9	1,860.4	1,999.1	2,409.7	2,710.2	(0.52)	0.48
Waterway improvement materials	570.5	611.7	611.7	611.7	611.7	611.7	0.50	0.11
BEA 47: Huntsville, AL	160.5	165.5	170.0	183.3	200.9	206.7	0.41	0.40
Petro, coal products	31.6	32.4	50.0	54.4	45.5	32.0	3.33	0.02
Slag, iron and steel	128.9	133.1	120.0	128.9	155.4	174.7	(0.51)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	341.9	357.8	373.2	402.6	438.0	447.5	0.63	0.42
Petro, coal products	67.3	74.3	117.8	128.1	107.2	75.4	4.08	0.18
Slag, iron and steel	274.6	283.5	255.4	274.5	330.8	372.1	(0.52)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV	452.9	501.2	504.4	568.2	714.7	804.4	0.77	0.90
Petro, coal products	253.3	295.2	318.8	368.8	474.3	534.1	1.66	1.17
Slag, iron and steel	199.6	206.0	185.6	199.4	240.4	270.3	(0.52)	0.47
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 54: Louisville, KY	274.4	277.6	281.9	303.9	335.4	347.9	0.19	0.37
Petro, coal products	54.0	50.0	76.8	83.5	69.8	49.1	2.55	(0.15)
Slag, iron and steel	220.4	227.6	205.1	220.4	265.6	298.8	(0.51)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 55: Evansville, IN	170.2	193.5	206.8	226.1	250.1	257.2	1.40	0.65
Petro, coal products	42.5	61.6	88.0	98.5	96.3	84.2	5.34	1.07
Slag, iron and steel	127.7	131.9	118.8	127.6	153.8	173.0	(-0.51)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--

(Continued)

Table E-15. (Continued)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
BEA 62: Cincinnati, OH	679.3	754.8	794.4	874.7	1,027.1	1,104.1	1.12	0.76
Petro, coal products	334.1	398.2	472.9	529.4	611.4	636.9	2.51	1.01
Slag, iron and steel	342.8	354.0	318.9	342.7	413.1	464.6	(0.51)	0.48
Waterway improvement materials	2.4	2.6	2.6	2.6	2.6	2.6	0.57	0.13
BEA 64: Columbus, OH	79.1	81.6	83.2	89.7	98.5	101.5	0.36	0.39
Petro, coal products	15.6	16.1	24.2	26.3	22.0	15.5	3.19	(0.01)
Slag, iron and steel	63.5	65.5	59.0	63.4	76.5	86.0	(0.52)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 66: Pittsburgh, PA	2,595.8	2,929.5	2,976.9	3,244.2	3,880.3	4,226.6	0.98	0.76
Petro, coal products	1,994.8	2,309.0	2,417.9	2,643.4	3,156.2	3,412.1	1.38	0.84
Slag, iron and steel	601.0	620.5	559.0	600.8	724.1	814.5	(0.52)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 115: Paducah, KY	619.8	660.9	660.7	664.6	670.9	673.6	0.46	0.13
Perto, coal products	10.2	9.0	13.0	14.1	11.8	8.3	1.75	(0.32)
Slag, iron and steel	41.5	42.8	38.6	41.4	50.0	56.2	(0.52)	0.47
Waterway improvement materials	568.1	609.1	609.1	609.1	609.1	609.1	0.50	0.11

Note: Petroleum products consumption for each BEA segment was projected based on the growth rates of consumption of Group XI (Petroleum Products, Nec.) Consumption of coal products for the ORB as a region is assumed to equal production. Distribution of ORB consumption to the BEA segments was made based on the projected steel production by BEAs. The consumption of waterway improvement materials for 1980 was projected based on the rate of growth of the COE budget on river maintenance and bank stabilization by river, deflated 9 percent per year to discount inflation. Consumption of waterway improvement materials in the post 1980 years is assumed to remain at the 1980 level.

a. BEA segment defined as counties which are ultimate origins or destinations of waterborne commerce movements.

Source: Petroleum Products, Nec., (Group XI) and Iron Ore, Steel and Iron (Group VIII) Reports. The COE proposed budget on river maintenance and bank stabilization, and the Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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APPENDIX F

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Table F-1. Ohio River System: Waterborne Traffic of Coal and Coke, by Origin BEA, Shipping BEA, Receiving BEA and Destination BEA, Estimated 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	SHIPPING BEA	RECEIVING BEA	DESTINATION BEA	FOR COMMODITY GROUP 01 IN HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
011	066	066	066	1021	1173	1387	1865	3493	5093
048	048	048	048	5661	10343	4450	3419	1845	708
048	047	052	052	45	48	54	64	67	90
048	047	077	077	1636	1449	2339	2876	2649	2097
048	048	077	077	200	177	286	352	324	256
048	048	089	089	189	138	185	258	241	198
048	047	137	137	234	177	236	296	254	206
048	048	138	138	7782	3004	9735	13945	15673	16498
049	115	052	052	794	934	1209	1325	1423	1450
049	115	062	062	667	752	1200	1344	1511	1737
050	048	048	048	315	565	295	227	151	65
050	062	052	052	236	263	337	368	390	341
050	062	062	062	2683	2750	4003	4427	5049	5908
050	054	066	066	381	581	709	827	961	932
050	062	066	066	341	520	635	740	860	834
050	062	114	114	56	48	86	100	90	74
050	062	115	115	682	648	665	787	889	1123
050	048	138	138	432	312	632	679	576	463
051	048	048	048	315	593	312	240	161	65
051	052	052	052	3299	3530	4704	5163	5196	5239
051	052	055	055	39	42	54	55	66	72
051	052	062	062	2533	2685	4210	4557	4714	5557
051	052	065	065	378	399	486	541	588	637
051	052	066	066	4723	5039	6419	7363	9134	10358
051	066	066	066	345	368	469	538	667	757
051	052	114	114	210	175	342	389	400	329
051	052	115	115	54	48	57	64	67	84
051	052	137	137	186	152	270	297	260	226
051	048	138	138	432	381	541	582	565	458
051	052	138	138	14	12	18	19	18	15
051	052	141	141	168	133	247	276	241	189
052	052	047	047	2408	2143	1664	1194	937	491
052	052	049	049	880	1082	1195	1144	1045	950
052	052	052	052	88634	109818	171507	181345	168139	159807
052	062	052	052	785	973	1519	1606	1489	1415
052	064	052	052	3130	3878	6057	6404	5938	5643
052	052	054	054	192	348	427	648	683	720
052	052	055	055	1144	1395	1758	1541	1510	1455
052	052	062	062	49058	56368	92033	113716	100814	113864
052	054	062	062	10	11	19	23	21	23
052	062	062	062	3057	3512	5735	7086	6282	7095
052	052	064	064	3838	4679	22218	27342	36833	45212
052	052	065	065	7182	8374	11103	12583	13287	14127
052	052	066	066	104936	127917	172830	184687	241773	270525
052	054	066	066	341	464	628	671	878	982
052	062	066	066	250	305	412	440	576	645
052	064	066	066	90	110	149	158	207	232
052	066	066	066	3353	4087	5522	5901	7725	8644
052	052	077	077	96	85	130	200	300	350
052	052	091	091	105	93	158	250	200	160
052	052	114	114	4508	3908	7330	8191	5423	4449
052	052	115	115	1036	1077	1313	1467	1664	1994

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Table F-1. (Continued)

ORIGIN REA	SHIPPING REA	RECEIVING REA	DESTINATION REA	FOR COMMODITY GROUP 01 IN HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
052	054	115	115	2470	2569	3129	3498	3967	4755
052	052	137	137	6064	5348	10369	11425	7550	6119
052	052	138	138	355	312	441	444	417	389
052	066	138	138	89	78	111	111	105	97
052	052	141	141	3194	2839	5720	6241	4107	3280
053	052	047	047	602	501	356	278	227	93
053	052	052	052	2742	3126	4069	4382	4140	3724
053	062	052	052	236	269	350	377	356	320
053	052	054	054	48	58	82	91	129	137
053	052	055	055	96	102	128	127	128	137
053	052	062	062	2777	3171	4213	4663	5099	5646
053	062	062	062	3557	4062	5396	5972	6531	7231
053	052	064	064	26	31	37	45	55	78
053	052	066	066	719	823	1017	1121	1491	1748
053	054	066	066	190	218	269	296	394	462
053	062	066	066	474	543	670	739	983	1152
053	052	114	114	67	58	106	118	112	92
053	062	114	114	83	72	131	147	138	114
053	062	115	115	1023	999	1006	1178	1287	1580
053	052	137	137	282	236	421	454	308	248
055	055	038	038	14941	13223	26550	28941	19169	15150
055	055	039	039	530	470	942	1029	687	547
055	115	039	039	3895	3451	6925	7564	5048	4024
055	055	046	046	8029	7106	14251	15568	10390	8286
055	115	046	046	7568	6698	13433	14674	9793	7810
055	047	047	047	26670	24163	17229	12855	9868	3867
055	055	047	047	3841	3480	2481	1851	1421	557
055	055	048	048	529	1752	933	717	602	266
055	049	049	049	979	1272	874	468	398	112
055	055	049	049	64590	83902	57679	30874	26288	7363
055	115	049	049	70	91	63	33	28	8
055	055	052	052	13506	17153	25796	27201	27701	30983
055	055	054	054	82568	97017	145567	179668	230943	264135
055	055	055	055	8840	10201	12942	20403	11253	8946
055	055	057	057	33	39	55	59	60	61
055	055	062	062	57331	78027	135129	153876	190626	217628
055	062	062	062	4369	5946	10298	11726	14527	16585
055	054	066	066	317	1235	1825	1943	2869	3148
055	062	066	066	665	2590	3829	4076	6020	6603
055	055	077	077	6158	5450	11589	12254	7223	5672
055	115	077	077	223	197	420	444	262	205
055	055	079	079	609	700	989	1065	1072	1093
055	115	079	079	211	242	343	369	372	379
055	055	081	081	2560	2268	4552	4972	3318	2647
055	055	089	089	1648	1493	3093	3317	2134	1681
055	115	089	089	145	131	272	292	188	146
055	055	091	091	1496	1325	2687	2859	1874	1495
055	062	091	091	17	15	31	32	21	17
055	115	091	091	11	10	20	21	14	11
055	115	113	113	187	191	270	291	293	299
055	055	114	114	5112	4596	9677	10413	6789	5301
055	062	114	114	139	125	263	283	185	144
055	115	114	114	1669	1500	3159	3400	2216	1731
055	055	115	115	11530	12360	13398	15600	16142	14751
055	062	115	115	1705	1828	1981	2307	2387	2921
055	115	115	115	1350	1447	1569	1827	1890	2313
055	115	135	135	67	78	110	119	120	122
055	055	137	137	6268	5660	11859	12837	8524	6688
055	115	137	137	735	664	1391	1505	1000	784
055	047	138	138	45	46	87	90	50	33
055	055	138	138	29805	30341	57613	59729	32964	22115
055	115	138	138	78	79	151	156	86	58

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Table F-1.(Continued)

ORIGIN BEA	SHIPPING BEA	RECEIVING BEA	DESTINATION BEA	FOR COMMODITY GROUP 01 IN HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
055	055	915	915	6458	5715	11469	12529	8363	6665
065	066	062	062	294	362	431	472	509	593
065	065	065	065	12347	13125	15866	16878	17594	18323
065	066	065	065	161	171	207	220	229	239
065	065	066	066	35540	38596	47126	51711	54554	57717
065	066	066	066	60368	65560	80048	87835	92665	98038
065	066	138	138	89	79	158	157	90	95
066	066	038	038	78	69	118	200	271	356
066	066	048	048	22	0	0	0	0	0
066	066	049	049	5670	6169	8930	8227	7745	6804
066	062	052	052	314	332	552	607	598	598
066	066	052	052	17520	18519	30800	33884	33393	33341
066	066	055	055	60	0	0	0	0	0
066	062	062	062	1213	1198	1416	1789	1998	2319
066	066	062	062	29742	29385	34709	43869	48985	56867
066	066	064	064	98	0	0	0	0	0
066	065	065	065	3333	3350	3493	3840	4156	4516
066	066	065	065	787	791	825	907	981	1066
066	067	066	066	100	105	109	120	132	145
066	065	066	066	14228	14868	15537	17002	18824	20616
066	066	066	066	238765	249509	260731	285324	315886	345970
066	066	114	114	60	53	58	62	60	59
066	066	115	115	350	288	285	426	444	545
066	066	137	137	57	0	0	0	0	0
066	065	138	138	177	157	308	316	311	354
068	068	066	066	22	29	11	11	11	13
068	068	114	114	22	17	15	16	14	10
077	077	047	047	43	35	33	32	30	17
077	077	048	048	55	66	51	39	45	26
077	077	055	055	345	392	499	716	1399	2107
114	114	049	049	2820	2924	3725	3869	7312	5725
114	114	052	052	10200	11597	13413	21440	40045	53917
114	115	052	052	794	903	1044	1669	3117	4197
114	114	054	054	0	0	0	0	15000	42195
114	114	055	055	0	0	90000	100800	142830	173520
114	115	062	062	667	707	900	1207	2283	3387
114	114	066	066	0	0	0	17450	63675	117107
115	115	052	052	795	884	920	1058	1349	1422
115	115	062	062	766	816	1068	1255	1683	2020
115	055	089	089	45	34	52	67	63	68
115	055	115	115	850	772	657	841	1126	1560
114	114	066	066	534	595	703	941	1762	2570
137	137	055	055	223	257	2190	2572	3276	3885
138	138	047	047	40	33	44	42	60	68
138	138	052	052	33	36	38	50	86	120
138	138	055	055	245	279	331	465	871	1273
138	138	066	066	56	69	81	110	233	361
141	141	052	052	1380	1540	1822	2447	4582	6682
143	143	047	047	50	50	34	35	27	11
143	143	052	052	80	85	137	145	161	186
143	143	115	115	20	19	19	20	21	26
144	144	047	047	56	52	37	28	21	10
915	915	048	048	1450	3918	1781	1367	1523	857
915	915	052	052	4940	3957	8067	11441	20303	30579
915	915	062	062	100	115	150	249	498	550
915	915	066	066	90	182	339	533	2960	2700
915	915	115	115	3540	3101	2995	4322	8262	14241
			TOTAL	1165329	1303906	1834957	2041608	2281002	2536569

Note: BEA 915, which consists of counties of BEA 115 which are origins/destinations of waterborne movements shipped from/to points coal as does BEA 114. For PSAs, the origin BEA is defined at the production point. Shipping and receiving BEAs refer only to waterborne portion of the flow from origin to the point of ultimate consumption.

Source: Robert R. Nathan Associates, Inc.

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Table F-2. Ohio River System: BEA-to-BEA
Waterborne Traffic of Petroleum Fuels,
Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
038	049	02	100	106	129	141	119	84
046	049	02	3338	2884	3014	5184	4463	3351
046	052	02	212	200	161	257	549	1457
046	054	02	1037	0	0	0	0	0
046	055	02	979	708	59	0	0	0
046	062	02	275	141	0	0	0	0
046	064	02	33	20	15	30	32	32
046	066	02	963	626	491	886	862	822
046	068	02	134	81	56	109	112	116
046	115	02	75	66	60	94	81	67
047	052	02	80	84	108	111	91	64
047	066	02	51	50	59	67	58	40
047	141	02	430	439	549	585	489	341
049	049	02	100	106	131	141	118	82
052	049	02	20	0	0	0	0	0
052	052	02	11810	23573	47216	34887	21258	8692
052	054	02	5880	7568	11290	9743	5951	2164
052	055	02	1770	3565	8845	3698	2092	550
052	062	02	10670	13434	13370	15205	13626	8995
052	064	02	3298	4271	6932	6540	4947	2444
052	066	02	12890	18355	29196	25071	18098	6058
052	068	02	3000	4089	5655	5157	3873	1908
052	114	02	140	244	227	352	203	242
052	137	02	89	135	221	181	126	56
052	138	02	230	377	375	525	335	329
053	052	02	30	31	38	40	33	23
054	049	02	50	92	170	66	49	10
054	052	02	740	807	1238	1225	897	143
054	054	02	770	801	918	1133	1029	753
054	055	02	10	14	27	19	13	12
054	062	02	360	309	249	300	358	229
054	064	02	30	27	31	42	39	31
054	066	02	400	400	458	520	451	334
054	068	02	610	555	544	703	661	542
054	114	02	356	390	278	563	465	886
055	046	02	5007	6239	5693	8136	5618	6519
055	047	02	1070	1552	2889	2012	1404	574
055	048	02	1480	2256	3872	2813	1991	728
055	049	02	901	1688	4103	1444	1260	210
055	052	02	3890	6983	14751	9130	5773	0
055	054	02	5241	3234	4796	3716	2872	818
055	055	02	1580	1967	5756	3079	1913	0
055	057	02	210	244	376	317	227	110

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Table F-2. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
055	062	02	4095	3223	3579	4525	4124	0
055	064	02	700	676	1037	979	777	142
055	066	02	1307	1312	1988	1666	1246	427
055	068	02	511	518	691	621	508	274
055	077	02	1270	1585	1459	2182	1519	1759
055	078	02	1170	1455	1333	2007	1399	1642
055	079	02	500	581	894	755	540	262
055	114	02	2247	2780	2620	3786	2611	2719
055	115	02	2055	2339	4073	2988	2096	812
055	134	02	22	26	40	33	24	12
055	138	02	673	786	734	1066	735	774
055	140	02	20	23	36	30	22	11
055	915	02	33	38	60	50	36	17
062	052	02	3822	7162	6968	9203	8210	4361
062	054	02	8639	5071	3983	6635	6600	6376
062	055	02	540	715	979	886	681	399
062	062	02	1956	1530	833	1178	1305	4663
062	064	02	1120	921	816	1331	1362	1858
062	066	02	1239	1157	978	1461	1386	1336
062	115	02	1060	1320	1302	1639	1477	1236
062	138	02	113	108	58	154	141	306
062	915	02	56	55	48	68	64	62
064	066	02	10	9	13	14	11	8
066	052	02	1340	1503	2057	1855	1386	913
066	054	02	78	50	58	174	156	109
066	064	02	300	260	321	411	373	253
066	065	02	1600	1453	1741	1909	1598	1118
066	066	02	3441	3372	4122	4800	4140	2884
066	068	02	81	75	80	103	93	73
066	077	02	33	37	25	51	38	68
066	138	02	22	20	15	33	29	46
068	052	02	90	169	319	157	33	24
068	062	02	22	32	36	28	11	6
068	064	02	175	155	181	225	205	127
068	065	02	1350	1243	1412	1505	1257	873
068	066	02	2423	2464	2857	3244	2796	1953
068	068	02	210	195	199	240	214	166
077	048	02	846	677	617	923	843	680
077	049	02	156	65	51	103	81	122
077	052	02	99	24	4	9	15	11
077	054	02	170	115	53	135	132	125
077	055	02	20	7	1	1	0	0
077	064	02	111	64	53	151	158	229
077	115	02	30	10	6	13	12	22
078	066	02	350	343	427	474	396	277
079	055	02	20	23	34	30	22	11
114	047	02	1320	1148	1089	1599	1441	1172
114	048	02	1057	1033	937	1402	1285	1080
114	049	02	2107	1943	2014	2040	1700	2248

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Table F-2.(Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
114	052	02	56	249	100	156	187	212
114	054	02	7179	1400	998	2907	4035	3762
114	055	02	5631	5479	4848	8655	6797	4370
114	062	02	2016	871	0	0	0	0
114	066	02	1919	2094	1606	2994	2913	4792
114	068	02	145	93	60	113	123	120
114	115	02	460	379	339	525	472	415
115	046	02	80	91	100	579	463	613
115	047	02	120	166	134	122	100	60
115	066	02	30	0	0	0	0	0
115	115	02	3310	3479	4214	4071	3426	2112
115	140	02	230	243	289	310	259	181
119	062	02	111	108	96	135	127	123
119	068	02	134	134	157	170	142	99
134	049	02	492	467	475	723	600	578
134	054	02	740	471	348	639	629	601
134	055	02	40	38	0	0	0	0
134	062	02	30	17	0	0	0	0
134	064	02	11	6	5	9	10	10
134	066	02	820	432	340	615	607	581
137	054	02	2010	213	139	291	299	287
137	055	02	280	541	587	871	712	474
137	062	02	122	260	10	243	354	687
137	115	02	553	974	887	1354	1199	1011
138	047	02	1603	1404	1335	1935	1755	1431
138	048	02	245	216	195	295	272	328
138	049	02	5922	6650	7326	8729	7136	4145
138	052	02	5756	4231	2147	3379	3143	1577
138	054	02	7237	1165	839	1570	1541	2055
138	055	02	1470	1345	1044	1405	1108	635
138	062	02	1518	820	237	4326	4419	8436
138	064	02	1351	767	638	1265	1279	1288
138	066	02	10991	7210	5550	10189	10178	9870
138	068	02	1071	638	437	864	862	944
138	115	02	2811	2375	2148	3283	2909	2462
139	064	02	22	22	31	34	28	20
140	047	02	220	182	149	258	239	202
140	048	02	1102	923	775	1272	1177	1027
140	050	02	378	399	476	512	435	298
140	052	02	1114	628	475	902	743	477
140	054	02	72	24	16	51	51	48
140	062	02	271	118	50	139	222	679
140	066	02	865	433	286	634	626	601
140	068	02	120	69	41	85	87	96
140	115	02	30	20	15	30	28	31
141	047	02	133	117	111	161	147	112

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Table F-2. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
141	048	02	378	346	315	463	425	340
141	049	02	70	83	98	208	174	124
141	052	02	1500	1079	879	1335	1172	1241
141	054	02	770	606	463	887	861	821
141	055	02	180	172	217	251	182	111
141	064	02	33	21	16	31	33	33
141	066	02	3033	1741	1392	2517	2378	2281
141	068	02	1150	697	477	897	900	950
143	052	02	440	314	259	412	379	364
143	054	02	60	24	18	57	56	53
143	066	02	40	26	20	36	34	32
144	049	02	11	11	15	16	13	9
		TOTAL	209434	211662	271799	283004	226270	158071

Note: BEA 915 refers to counties of BEA 115 which are destinations of waterborne movements shipped to points on the Mississippi River.
Source: Robert R. Nathan Associates, Inc.

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Table F-3.Ohio River System: BEA-to-BEA
Waterborne Traffic of Crude Petroleum
Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
038	055	03	412	416	587	548	420	244
077	064	03	857	1774	607	567	434	254
114	064	03	256	530	181	169	130	75
138	055	03	4564	4610	6499	6075	4646	2706
138	064	03	523	1082	371	347	265	153
140	066	03	33	58	23	22	17	10
		TOTAL	6645	8470	8268	7728	5912	3442

Source: Robert R. Nathan Associates, Inc.

Table F-4. Ohio River System: BEA-to-BEA
Waterborne Traffic of Aggregates
Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
047	047	04	1358	1156	944	706	835	906
047	048	04	100	86	0	0	0	0
048	047	04	679	711	940	1034	1410	1505
048	048	04	12653	13653	13425	12387	14462	15728
048	050	04	122	143	59	50	61	68
049	047	04	879	1274	1835	2368	3229	3837
049	049	04	11807	12693	13413	13472	15503	16494
050	048	04	0	0	0	119	208	251
050	050	04	1146	1052	1149	1078	1207	1286
052	052	04	19195	22957	23322	23380	24435	25107
052	064	04	468	606	3515	3924	5304	5955
052	066	04	45	218	603	2668	5724	7434
054	052	04	7495	7900	8387	7705	7802	7622
054	053	04	5390	5428	5174	4668	5573	6075
054	054	04	24958	25083	25233	25058	31297	34841
054	055	04	3670	4198	2173	2041	2455	2653
054	062	04	4060	7004	7085	8522	10662	12143
054	064	04	510	592	1011	1845	2024	2267
054	066	04	0	100	5856	7173	7617	7620
054	135	04	67	42	52	51	69	74
055	052	04	479	1027	1555	1734	1754	1947
055	055	04	12756	11544	11506	10626	13190	14593
055	064	04	0	0	0	4100	5219	5740
055	066	04	0	0	8518	14915	14907	14992
055	077	04	139	199	218	227	268	291
055	115	04	6570	6320	9507	6294	9481	11110
062	052	04	6276	5052	4330	4481	4531	4381
062	055	04	20	24	0	0	0	0
062	062	04	16614	16880	19173	20070	24755	27463
062	064	04	309	323	522	634	814	917
062	066	04	1100	1140	1536	1319	1238	1263
062	068	04	78	72	102	136	163	172
064	052	04	11	0	0	0	0	0
064	064	04	1782	2007	3200	3338	4065	4414
064	066	04	288	421	133	100	0	0
065	066	04	6722	8147	11858	13367	16402	17813
066	052	04	2122	0	0	0	0	0
066	054	04	1250	1181	865	701	2258	3068

(Continued)

Table F-4. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
066	062	04	1250	0	0	0	0	0
066	064	04	11468	12695	11617	9174	11651	13142
066	066	04	45232	49212	37181	32567	36231	38221
066	068	04	913	996	1078	1182	1437	1578
068	066	04	4665	5113	5589	5817	6876	7469
115	046	04	4495	4733	5174	5385	6365	6913
115	047	04	0	0	0	62	86	94
115	048	04	0	0	1633	2993	4331	4966
115	049	04	14425	9362	8770	7660	11468	13718
115	050	04	0	100	48	40	71	79
115	054	04	0	498	1606	1662	1698	1702
115	055	04	0	1000	2660	2759	2819	2895
115	062	04	0	2374	4333	4791	6047	6619
115	115	04	9303	10336	12717	16010	16038	16141
115	133	04	22	23	25	26	31	34
115	134	04	2382	2506	2742	2854	3373	3664
115	135	04	356	403	435	456	531	577
115	137	04	0	1800	1967	2048	2423	2630
115	138	04	4731	4982	5450	5668	6704	7281
115	139	04	56	3659	4003	4165	4926	5349
115	140	04	244	2657	2907	3025	3578	3885
115	141	04	56	3059	3346	3481	4117	4470
115	915	04	56	59	65	67	79	86
117	055	04	11	12	14	15	18	19
138	062	04	22	23	27	30	35	38
915	064	04	45	24	0	0	0	0
915	068	04	623	681	816	902	1067	1160
		TOTAL	251523	275540	301402	313637	370922	402760

Note: BEA 915 refers to counties of BEA 115 which are origins and destinations of waterborne movements shipped from and to points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

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Table F-5. Ohio River System: Waterborne Traffic of Grains, by Origin BEA, Shipping BEA, Receiving BEA and Destination BEA, Estimated 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	SHIPPING BEA	RECEIVING BEA	DESTINATION BEA	FOR COMMODITY GROUP 05 IN HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
046	047	047'	045	10	7	9	16	17	21
046	047	047	047	19	14	6	10	13	14
046	047	047	048	19	14	22	38	41	47
046	047	111	111	10	7	11	19	21	24
046	047	137	137	29	21	33	56	66	76
046	047	138	138	127	92	160	277	331	381
049	115	038	038	11	12	13	17	22	28
049	047	047	045	11	9	11	16	17	21
049	047	047	047	23	20	8	10	13	15
049	047	047	048	26	24	29	41	43	49
049	047	048	048	22	21	25	34	37	41
049	048	050	050	20	22	26	30	33	37
049	055	055	055	50	41	56	79	118	145
049	047	111	111	12	11	14	19	23	26
049	047	137	137	37	32	41	57	64	71
049	055	137	137	10	9	11	16	17	19
049	047	138	138	350	317	399	550	617	686
049	048	138	138	62	56	71	97	109	122
049	049	138	138	64	58	73	100	113	126
049	055	138	138	1695	1536	1932	2661	2987	3324
049	115	138	138	300	272	342	471	529	588
052	052	141	141	11	8	10	12	14	15
053	062	137	137	11	8	10	13	15	17
053	062	138	138	325	230	287	370	436	498
053	062	946	946	10	7	9	12	14	16
054	054	047	045	24	20	21	30	36	38
054	054	047	047	35	31	11	11	13	16
054	054	047	048	28	28	34	44	53	65
054	054	055	055	13	10	14	22	43	82
054	054	138	138	11	10	13	17	21	27
054	062	138	138	1027	929	1170	1556	2004	2497
055	055	038	038	20	9	12	17	23	32
055	055	047	044	11	8	13	19	36	62
055	055	047	045	69	39	52	66	92	124
055	055	047	047	112	47	23	32	53	59
055	055	047	048	109	46	78	109	145	143
055	055	048	048	200	85	142	200	267	336
055	055	115	115	20	19	20	21	21	22
055	055	137	137	416	184	259	344	514	683
055	055	138	138	17651	7731	10908	15392	21605	28753
055	062	138	138	100	44	62	87	122	163
055	115	138	138	75	33	46	65	92	122
055	055	140	140	31	13	19	27	38	50
055	055	141	141	63	26	37	55	75	98
055	055	143	143	30	13	19	26	37	49
055	055	914	914	92	41	57	80	113	151
055	055	946	946	59	24	36	49	69	91
056	055	047	047	12	8	3	5	8	10
056	055	048	048	12	7	10	14	21	29
056	055	137	137	20	12	17	23	34	47
055	055	138	138	720	432	612	849	1252	1704
057	057	047	045	14	13	11	10	8	8

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Table F-5.(Continued)

ORIGIN REA	SHIPPING REA	RECEIVING REA	DESTINATION REA	FOR COMMODITY GROUP 05 IN HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
057	057	047	047	55	56	51	37	32	27
057	057	047	048	19	21	19	17	16	14
057	057	048	048	30	32	30	28	26	23
060	054	047	045	11	8	9	11	15	16
060	054	047	047	16	13	5	5	6	8
060	062	047	047	15	12	4	4	5	8
060	054	047	048	15	12	15	18	26	33
060	062	048	048	20	17	21	25	34	45
060	062	055	055	14	11	15	21	43	69
060	062	137	137	31	26	31	37	55	72
060	054	138	138	506	408	499	613	887	1158
060	062	138	138	1785	1440	1760	2162	3129	4086
060	062	914	914	11	9	11	14	21	27
060	062	946	946	14	12	14	18	25	32
061	062	048	048	14	3	5	8	14	20
061	062	137	137	10	2	4	6	10	15
061	062	138	138	509	107	199	317	538	781
062	062	038	038	13	9	14	17	19	17
062	062	047	045	27	21	26	35	37	39
062	062	047	047	42	37	15	17	18	19
062	062	047	048	35	32	44	52	58	64
062	062	048	048	41	38	52	61	68	75
062	062	055	055	35	28	42	51	76	120
062	062	133	133	12	9	13	16	19	21
062	062	137	137	145	124	154	188	217	248
062	062	138	138	8460	7360	9154	11006	12842	14695
062	062	914	914	42	38	45	56	66	75
062	062	946	946	69	60	75	91	106	123
063	062	047	047	13	8	4	5	0	0
063	062	048	048	17	13	25	34	41	48
063	062	055	055	10	6	11	16	28	32
063	062	137	137	30	22	40	57	66	76
063	062	138	138	1744	1289	2410	3342	3943	4547
063	062	914	914	11	8	15	21	25	28
063	062	946	946	14	11	19	27	32	37
064	062	048	048	15	10	14	18	21	24
064	062	055	055	12	8	13	16	26	29
064	062	137	137	12	9	13	15	17	19
064	062	138	138	708	496	708	887	995	1109
064	064	138	138	22	15	27	28	31	34
077	077	047	044	26	26	26	25	23	20
077	077	047	045	332	325	261	229	182	145
077	077	047	047	603	611	551	430	403	325
077	077	047	048	381	405	389	333	296	290
077	077	048	048	133	141	136	116	103	101
078	078	047	044	16	15	16	15	14	12
078	078	047	045	232	228	182	154	122	96
078	078	047	047	601	607	549	428	392	313
078	078	047	048	263	282	267	230	204	203
078	078	048	048	100	107	102	87	77	77
078	078	062	062	11	11	11	12	13	13
079	079	047	045	20	20	16	14	12	5
079	079	047	047	64	65	59	43	39	34
079	079	047	048	26	28	27	24	22	20
079	079	048	048	90	95	92	82	77	70
079	079	055	055	20	20	20	22	20	25
081	081	047	047	11	11	10	8	7	6
089	089	047	047	33	34	30	22	19	17
089	089	048	048	31	33	32	29	26	23
091	091	047	044	10	10	10	10	10	9
091	091	048	044	85	83	84	84	82	76
091	091	047	045	149	147	117	96	81	66

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Table F-5. (Continued)

ORIGIN BEA	SHIPPING BEA	RECEIVING BEA	DESTINATION BEA	FOR COMMODITY GROUP 05 IN HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
091	091	047	047	687	702	671	490	390	344
091	091	047	048	138	148	141	125	119	110
091	091	048	048	2734	2925	2786	2474	2357	2171
091	091	050	048	31	33	32	28	27	25
091	091	050	050	58	79	73	63	60	55
091	091	055	055	562	545	561	613	597	601
103	103	048	048	22	24	23	20	19	18
103	103	055	055	11	10	11	12	12	11
107	107	047	045	10	11	8	6	5	5
107	107	047	047	57	58	51	39	35	30
107	107	047	048	10	10	10	9	8	7
107	107	048	048	55	58	57	51	46	41
108	108	048	048	11	12	11	10	10	10
111	111	046	044	67	65	68	66	64	58
111	111	047	045	41	42	32	24	21	8
111	111	047	047	638	648	618	455	368	330
111	111	048	048	2193	2362	2239	1985	1890	1772
111	111	050	050	11	15	14	13	12	12
111	111	055	055	889	859	888	967	960	916
112	112	047	047	11	11	10	8	7	6
113	113	047	044	12	11	12	12	10	9
113	113	047	045	60	60	47	42	34	32
113	113	047	047	95	96	87	64	62	52
113	113	047	048	91	97	93	83	74	65
114	055	047	047	12	14	50	74	84	97
114	055	048	048	12	14	115	170	187	205
114	055	138	138	301	351	304	448	550	656
114	115	138	138	38	44	38	57	69	83
114	055	914	914	11	12	15	22	26	29
114	055	946	946	10	12	14	21	25	30
115	055	047	047	10	6	2	4	4	6
115	115	048	048	39	30	49	75	81	87
115	115	117	117	10	8	11	16	18	21
115	115	133	133	10	9	11	16	18	21
115	115	137	137	10	8	11	16	18	21
115	049	138	138	52	40	56	83	95	111
115	055	138	138	250	191	271	398	456	532
115	115	138	138	2078	1588	2253	3306	3786	4424
115	115	141	141	27	22	31	43	51	62
115	055	914	914	11	7	12	16	16	21
115	115	946	946	15	12	16	23	27	31
117	117	050	050	11	15	14	13	13	12
119	119	048	044	25	25	26	25	23	22
119	119	047	047	11	12	20	8	6	3
119	119	048	048	821	878	837	749	700	647
134	134	048	048	22	23	23	21	20	20
138	138	047	047	11	11	10	8	7	6
141	141	055	055	20	19	20	23	24	25
914	914	048	044	11	11	11	11	10	9
914	914	047	045	115	112	90	73	57	44
914	914	047	047	1002	1006	908	714	629	540
914	914	047	048	65	73	66	51	44	36
914	914	048	048	156	176	159	121	106	90
915	915	047	047	20	20	18	14	12	11
915	915	048	048	33	36	34	30	28	25
915	915	050	050	11	15	14	12	11	10
			TOTAL	55820	41535	49966	60430	72750	86374

Note: BEAs 915, 914 and 946 refer to counties of BEAs 115, 114 and 46 which are origins and destinations of waterborne movements which are shipped from and to points on the Mississippi River. For PSA, the origin and destination BEAs are defined as points of production and consumption. Shipping and receiving BEAs refer only to that portion of the traffic flow which is waterborne (i.e., points of modal transfer).

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Table F-6. Ohio River System: BEA-to-BEA Waterborne Traffic of Chemicals and Chemical Fertilizers, Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
038	052	06	67	74	82	99	140	168
039	066	06	11	11	12	15	20	24
045	052	06	150	166	184	221	314	377
046	054	06	56	58	82	115	200	266
046	055	06	45	28	42	57	93	119
046	062	06	211	225	286	370	573	722
047	046	06	100	125	212	329	663	943
047	047	06	256	347	650	1037	2122	2960
047	048	06	11	17	31	56	101	137
047	049	06	11	13	23	35	71	98
047	052	06	550	658	827	1142	2572	3934
047	055	06	119	104	205	335	698	1000
047	062	06	227	315	625	1080	1916	2568
047	066	06	102	125	204	314	594	835
047	077	06	444	550	988	1528	3070	4345
047	078	06	33	40	69	107	216	307
047	079	06	33	41	69	107	216	307
047	089	06	111	136	228	355	717	1021
047	091	06	45	56	93	145	292	416
047	107	06	22	27	46	71	143	203
047	108	06	56	69	116	180	364	518
047	113	06	78	97	162	251	507	722
047	114	06	45	57	95	147	298	424
047	141	06	289	358	600	932	1881	2681
047	915	06	22	27	47	72	144	207
048	049	06	45	62	104	163	299	405
048	077	06	44	57	87	127	237	324
048	078	06	134	172	243	354	665	914
048	079	06	100	130	196	287	538	737
048	081	06	56	71	106	156	289	397
048	115	06	20	25	45	57	112	156
049	052	06	264	296	367	484	800	1031
049	055	06	50	60	90	125	212	275
052	039	06	21	26	32	41	65	82
052	046	06	301	371	449	578	921	1162
052	047	06	487	694	1122	2048	4565	6368
052	049	06	457	586	772	1096	1854	2399
052	052	06	5510	6766	7753	9246	13180	15924
052	054	06	160	203	263	354	619	791
052	055	06	90	79	121	162	254	315
052	062	06	295	394	582	841	1561	2114
052	066	06	1029	1258	1452	1791	2655	3275
052	068	06	10	12	16	19	30	43
052	077	06	1400	1736	2103	2712	4316	5457
052	078	06	56	70	85	111	177	224

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Table F-6. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
052	081	06	100	126	154	199	320	405
052	089	06	10	14	17	22	35	45
052	114	06	132	164	206	265	424	534
052	115	06	70	81	121	170	298	367
052	137	06	50	62	75	97	155	195
052	138	06	410	509	621	801	1275	1611
052	139	06	30	37	45	58	93	117
052	140	06	95	117	141	181	286	360
052	141	06	720	895	1090	1406	2237	2825
052	143	06	30	37	51	66	105	133
054	052	06	70	86	93	103	156	188
054	078	06	78	93	130	183	325	434
054	114	06	11	13	18	25	44	59
054	115	06	100	123	203	313	583	798
054	138	06	11	13	18	25	44	59
054	141	06	11	13	18	25	44	59
055	054	06	30	37	55	79	148	200
055	055	06	52	44	69	98	174	230
055	062	06	140	187	239	320	542	706
055	066	06	10	12	15	20	31	40
055	077	06	60	72	97	132	226	298
055	078	06	30	35	47	64	111	146
055	079	06	140	167	225	308	530	698
055	138	06	70	84	113	155	267	352
055	143	06	20	24	33	44	74	97
055	144	06	80	96	129	177	305	401
062	049	06	11	14	23	35	71	102
062	052	06	363	445	580	762	1181	1649
062	055	06	20	18	32	48	91	126
062	062	06	211	274	484	783	1678	2249
062	066	06	10	12	17	24	43	57
062	078	06	22	27	40	58	108	148
062	140	06	20	25	39	58	109	149
064	047	06	0	0	1823	3743	14064	24689
064	052	06	18020	21876	30616	43320	73161	94046
064	054	06	130	159	253	410	782	1142
064	062	06	160	304	555	847	1503	2231
066	046	06	141	166	226	314	542	716
066	047	06	105	141	420	652	1237	2008
066	049	06	22	27	38	51	89	113
066	052	06	4943	5773	7014	9115	16025	20143
066	054	06	111	131	189	281	547	744
066	062	06	851	1059	1866	2885	5935	8555
066	064	06	291	400	620	951	1972	2822
066	066	06	3303	3845	5344	7425	11197	14447

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Table F-6. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
066	077	06	43	51	70	96	167	220
066	078	06	60	76	120	168	292	385
066	114	06	101	120	156	216	374	493
066	115	06	50	61	116	185	351	451
066	138	06	250	296	401	553	960	1266
066	140	06	22	27	36	49	84	111
066	141	06	155	183	244	338	585	772
066	143	06	345	408	550	761	1322	1745
066	915	06	11	13	16	23	41	53
068	052	06	400	458	619	846	1473	1939
068	066	06	190	215	275	366	587	751
068	135	06	11	13	17	23	38	50
077	047	06	50	53	79	162	367	530
077	052	06	711	787	873	996	1307	1507
077	062	06	33	33	45	61	103	134
077	066	06	45	47	51	62	84	100
079	052	06	11	12	14	16	29	28
091	047	06	200	213	317	449	774	1035
107	054	06	22	23	33	47	83	110
107	062	06	67	71	91	118	182	230
108	054	06	67	69	90	119	190	243
113	055	06	89	54	72	92	134	165
114	049	06	470	457	580	753	1164	1470
114	054	06	11	11	15	19	29	39
114	055	06	360	220	289	385	583	731
114	062	06	111	119	153	208	328	411
114	066	06	484	483	520	627	798	927
114	115	06	350	316	443	575	889	1134
115	046	06	690	773	1090	1535	2734	3657
115	047	06	190	233	282	424	497	510
115	048	06	20	30	51	61	126	183
115	049	06	270	307	460	554	1002	1362
115	054	06	410	465	714	1020	1845	2419
115	062	06	350	394	543	757	1418	1949
115	066	06	30	31	35	43	70	82
115	077	06	1220	1364	1861	2623	4662	6242
115	111	06	50	56	79	111	198	265
115	114	06	240	267	378	533	954	1272
115	115	06	530	545	818	1241	2355	3275
115	119	06	20	22	32	45	79	106
115	133	06	67	75	106	149	266	355
134	062	06	140	150	198	262	424	544
135	047	06	78	86	132	182	308	408
135	052	06	89	96	101	124	180	219
137	047	06	856	914	1001	1201	1645	1959
137	048	06	167	189	301	436	793	1089
137	049	06	523	509	765	1064	1778	2353
137	055	06	1479	893	1378	1930	3155	4078

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BEST DOCUMENT AVAILABLE

Table F-6. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
137	062	06	67	71	96	130	208	264
138	047	06	365	399	627	529	446	376
138	048	06	2226	2642	3891	5576	10044	13556
138	049	06	2848	2785	3828	5272	8553	11070
138	052	06	3266	3227	1901	1270	699	385
138	054	06	733	770	1054	1425	2374	3126
138	055	06	4778	3015	4219	5691	8925	11281
138	062	06	5896	6397	8856	11692	17169	20553
138	064	06	1302	1452	2109	2982	5218	7048
138	066	06	5124	5088	5667	6835	9392	11442
138	068	06	78	70	98	119	174	247
138	115	06	1930	1774	2470	3443	5529	7158
140	047	06	234	256	855	1853	2758	3754
140	049	06	11	12	16	19	29	35
140	052	06	1961	2147	1875	1412	928	610
140	054	06	11	12	16	19	29	35
140	055	06	50	31	40	51	74	91
140	062	06	712	774	1053	1470	2558	3421
140	066	06	970	973	1073	1310	2681	3245
141	047	06	8263	9073	12733	17955	28714	35721
141	048	06	101	118	176	270	535	734
141	049	06	189	184	258	409	675	928
141	050	06	156	157	220	306	535	711
141	052	06	4067	4173	4254	3738	1850	915
141	054	06	1134	1190	1678	2351	4088	5459
141	062	06	2928	3183	4559	6685	14628	21395
141	064	06	426	479	715	1040	1940	2661
141	066	06	3154	3122	3655	4715	7043	8891
141	068	06	100	95	111	141	215	236
141	115	06	1013	928	1412	2029	3413	4550
143	047	06	190	217	393	525	840	1068
143	048	06	11	13	19	29	53	74
143	049	06	22	21	28	37	61	78
143	052	06	660	709	665	757	970	1100
143	055	06	11	7	9	13	19	24
143	062	06	270	294	427	604	1070	1444
143	064	06	22	24	33	45	83	112
143	066	06	22	22	26	32	48	59
143	115	06	10	10	15	21	34	45
144	047	06	60	66	95	143	264	361
144	049	06	11	11	14	18	29	37
144	052	06	260	284	317	370	501	587
144	054	06	11	12	15	20	32	42
144	066	06	64	65	73	89	124	150
915	054	06	22	22	31	42	67	86

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Table F-6.(Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
915	055	06	500	303	465	633	1001	1270
915	062	06	316	339	377	466	689	857
915	115	06	30	27	42	57	91	116
		TOTAL	113640	123960	165337	224196	375648	491953

Note: BEA 915 refers to counties of BEA 115 which are origins and destinations of waterborne movements shipped from and to points on tne Mississippi River.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table F-7. Ohio River System: BEA-to-BEA
Waterborne Traffic of Ores and Minerals
Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
038	066	07	33	36	42	50	68	83
047	115	07	470	603	975	1359	2404	3376
047	138	07	0	0	160	325	701	1029
048	114	07	11	12	16	23	38	63
049	091	07	170	183	246	368	610	1010
049	138	07	1500	1614	2168	3245	5381	8919
049	144	07	181	195	262	392	649	1077
052	055	07	45	76	289	442	916	1253
052	064	07	140	171	205	256	365	590
052	066	07	67	83	136	169	217	408
052	115	07	460	557	689	887	1323	1775
055	052	07	134	210	326	474	787	1016
055	066	07	31	32	35	40	60	80
055	068	07	33	47	99	157	326	490
055	077	07	207	316	724	1147	2282	3237
055	119	07	11	17	38	61	121	172
055	138	07	55	98	426	736	1622	2379
055	140	07	60	91	209	331	658	933
064	047	07	11	13	21	31	52	73
064	052	07	140	156	180	222	315	444
064	077	07	22	24	29	36	52	71
064	114	07	11	12	14	18	25	35
064	115	07	90	96	114	132	191	248
066	038	07	223	244	281	332	452	553
066	045	07	67	73	84	100	136	166
066	046	07	11	12	14	16	22	27
066	048	07	211	166	174	193	206	249
066	052	07	130	131	148	176	237	271
066	055	07	33	37	42	50	67	71
066	064	07	40	44	46	53	60	64
066	068	07	33	33	34	41	41	41
066	137	07	156	171	197	232	317	387
066	138	07	445	564	683	814	1199	1519
066	144	07	100	109	126	149	203	247
068	107	07	10	11	15	20	33	57
077	055	07	11	20	93	144	299	401
077	066	07	22	28	52	64	80	145
077	115	07	270	306	319	400	566	704
078	066	07	45	49	57	67	91	112
081	066	07	11	12	14	16	22	27
091	062	07	55	60	68	78	94	160
091	066	07	108	122	156	193	284	348

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Table F-7. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
113	052	07	10	13	19	25	40	57
114	062	07	89	103	127	161	239	358
114	064	07	11	14	30	36	46	67
115	052	07	120	138	172	223	331	426
115	115	07	20	22	22	24	32	48
115	138	07	11	15	30	40	71	97
137	049	07	768	1120	2570	4363	8750	12141
137	055	07	690	932	1488	2308	4084	5887
133	047	07	1669	2143	4036	5988	11049	15677
138	048	07	1324	1627	2988	4337	7805	10810
138	049	07	2028	2511	4437	5977	10245	14162
138	050	07	66	83	140	196	337	448
138	052	07	1674	2096	3236	4309	7022	10250
138	054	07	812	953	1283	1614	2352	3259
138	055	07	2527	3998	11020	15455	31181	44207
138	062	07	5719	6720	9190	11512	16568	24226
138	064	07	2948	3216	3815	4684	6801	9257
138	065	07	501	570	718	828	1022	1253
138	066	07	6255	6612	6730	7487	9013	11134
138	068	07	366	397	531	707	1151	2045
138	115	07	3983	4557	5747	7305	10858	14116
139	062	07	530	622	850	1067	1544	2320
140	062	07	89	105	143	179	260	390
141	066	07	178	197	235	281	395	502
141	068	07	22	22	23	28	40	66
143	055	07	3291	5019	10159	18229	36260	51455
143	066	07	43	58	69	110	151	175
144	052	07	78	102	150	198	317	449
144	062	07	197	231	333	413	591	1514
144	066	07	1540	1877	2988	3916	6517	7658
144	068	07	636	700	948	1247	2039	3571
915	062	07	22	26	31	75	221	368
915	115	07	430	498	642	786	1077	1349
		TOTAL	44510	54131	84906	118147	201981	284052

Note: BEA 915 refers to counties of BEA 115 which are origins of waterborne movements shipped from points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table F-8. Ohio River System: BEA-to-BEA Waterborne Traffic of Iron Ore, Steel and Iron, Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
038	052	08	11	13	16	20	32	39
038	054	08	10	13	22	31	56	77
046	049	08	22	36	74	115	216	303
046	066	08	111	212	340	435	709	925
046	068	08	82	108	123	135	174	200
047	064	08	20	21	33	51	105	148
047	066	08	202	342	632	990	1942	2791
047	068	08	50	29	40	54	89	111
047	077	08	88	125	249	356	643	868
047	078	08	11	15	22	33	60	79
047	089	08	33	46	75	111	212	293
047	091	08	133	182	223	294	480	619
047	114	08	33	46	76	122	334	464
047	117	08	44	55	60	71	104	122
047	137	08	11	17	22	27	42	52
047	141	08	10	15	29	48	103	148
047	144	08	11	13	14	19	34	45
048	066	08	96	155	298	357	507	602
048	068	08	21	9	13	13	15	16
048	077	08	11	15	25	28	36	40
048	144	08	56	67	70	78	97	111
049	066	08	174	239	585	680	936	1103
049	077	08	31	41	97	104	127	141
049	078	08	102	132	177	204	268	307
049	114	08	225	302	445	520	713	829
049	138	08	11	16	36	43	62	73
049	144	08	40	48	56	62	76	86
050	066	08	0	10	43	66	118	151
050	077	08	167	187	209	228	281	313
052	046	08	30	36	47	55	79	94
052	047	08	30	31	92	145	254	333
052	052	08	10	12	12	14	19	21
052	054	08	0	0	100	155	281	362
052	055	08	30	36	57	80	139	181
052	062	08	110	135	135	140	156	169
052	066	08	446	577	565	583	647	693
052	068	08	10	12	11	12	13	12
052	077	08	133	163	169	183	228	255
052	078	08	41	50	54	62	82	95
052	079	08	10	12	15	17	23	27
052	091	08	60	73	79	83	96	103
052	103	08	10	12	15	17	23	27
052	111	08	60	73	86	100	135	157

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Table F-8. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
052	114	08	121	149	170	198	269	313
052	115	08	191	227	295	342	435	480
052	117	08	10	11	12	12	12	12
052	118	08	50	63	66	76	103	119
052	135	08	100	117	138	159	214	249
052	138	08	60	78	104	125	277	335
052	141	08	210	265	342	413	498	586
054	046	08	50	57	109	134	187	214
054	062	08	11	13	20	21	24	27
054	066	08	642	729	1349	1630	2089	2361
054	077	08	85	95	151	171	207	222
054	114	08	21	23	40	49	66	73
054	137	08	21	16	24	24	26	26
054	141	08	31	36	69	85	220	249
055	062	08	22	27	37	40	46	49
055	066	08	377	474	767	905	1088	1273
055	077	08	33	39	55	60	75	85
055	114	08	22	26	40	47	64	76
055	115	08	11	12	20	23	29	33
055	138	08	67	82	143	169	342	411
055	141	08	33	40	69	83	180	214
055	144	08	11	12	12	12	16	18
062	046	08	11	16	21	23	31	36
062	054	08	0	0	100	154	287	367
062	066	08	556	811	873	934	1060	1173
062	077	08	22	31	32	33	39	42
062	141	08	32	47	60	79	180	208
064	047	08	100	108	180	237	387	488
064	052	08	20	21	21	23	31	34
064	054	08	21	27	69	71	82	90
064	055	08	20	23	43	65	125	168
064	066	08	11	20	23	30	40	45
064	068	08	40	60	57	59	68	72
064	077	08	244	265	275	306	396	456
064	091	08	11	13	15	16	19	21
064	114	08	73	83	102	122	175	207
064	138	08	10	11	17	20	29	35
066	039	08	11	13	13	14	17	20
066	046	08	905	1070	1103	1225	1565	1832
066	047	08	527	533	661	849	1957	2352
066	048	08	425	444	478	549	703	806
066	049	08	617	720	861	1174	1546	1798
066	052	08	10	12	11	15	33	37
066	054	08	2747	3445	3744	4214	4329	4862
066	055	08	686	805	989	1275	1940	2414
066	062	08	1763	1927	1918	1795	2237	2287
066	064	08	130	135	129	153	188	203
066	066	08	4202	4887	3462	3038	3164	3311
066	077	08	689	802	630	638	685	751
066	078	08	211	234	218	227	270	313

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Table F-8. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
066	091	08	281	308	312	314	323	330
066	107	08	11	13	13	14	17	20
066	111	08	43	52	53	57	70	79
066	114	08	1560	1810	1783	1925	2250	2565
066	115	08	53	56	57	57	66	75
066	117	08	22	24	26	27	27	34
066	118	08	448	521	522	565	688	784
066	119	08	342	398	392	424	515	587
066	133	08	11	13	13	14	17	20
066	134	08	32	38	37	40	49	55
066	135	08	81	101	104	114	139	159
066	137	08	20	28	21	24	29	36
066	138	08	3488	4119	4336	4820	5794	6700
066	140	08	171	199	196	212	258	293
066	141	08	3489	4103	4305	4759	5816	6776
066	915	08	80	94	93	100	122	139
068	046	08	22	30	38	45	64	76
068	047	08	32	33	44	57	66	84
068	054	08	10	14	24	29	35	40
068	066	08	22	34	28	28	39	46
068	077	08	22	27	27	29	34	37
068	078	08	22	27	27	31	40	45
068	141	08	89	117	154	172	242	271
077	047	08	1355	1890	2686	4011	6873	8985
077	048	08	312	495	779	972	1679	2242
077	049	08	790	1157	1552	1600	2188	2564
077	054	08	241	427	961	992	1514	1993
077	055	08	189	303	574	894	1827	2603
077	062	08	33	54	59	66	87	108
077	064	08	33	38	58	87	150	205
077	066	08	41	457	483	562	567	722
077	115	08	91	137	222	284	437	548
078	047	08	11	15	26	40	81	117
078	049	08	22	37	69	102	183	251
078	062	08	11	17	22	25	34	40
078	066	08	267	447	664	830	1297	1663
079	047	08	56	88	202	282	488	667
079	066	08	100	208	255	259	287	290
091	066	08	21	53	86	93	115	131
111	047	08	11	53	130	164	248	321
111	066	08	0	100	208	212	236	246
113	048	08	45	64	117	149	230	292
113	066	08	0	30	45	47	54	61
114	047	08	22	38	70	103	194	267
114	049	08	45	90	179	252	432	583
114	066	08	145	304	457	513	701	844
114	115	08	21	40	71	87	125	151
115	047	08	64	68	152	281	597	860
115	066	08	321	482	782	887	1166	1434

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Table F-8. (Continued)

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS 1976	1980	1990	2000	2020	2040
115	068	08	350	379	411	579	716	786
115	077	08	140	187	236	286	398	472
115	078	08	11	14	17	22	32	40
115	114	08	11	14	19	24	37	45
115	138	08	93	121	192	252	551	696
115	141	08	22	28	44	59	168	211
117	066	08	21	60	103	112	138	157
118	066	08	21	43	64	70	87	98
119	066	08	11	80	164	179	220	251
134	066	08	44	64	77	85	104	119
135	066	08	54	97	135	147	181	207
137	049	08	33	40	94	181	434	618
137	055	08	11	14	23	38	84	124
137	062	08	267	327	361	450	674	825
137	066	08	44	70	116	161	298	455
137	068	08	50	59	56	66	93	111
138	047	08	122	132	291	520	1612	3184
138	048	08	290	344	472	797	1486	2007
138	049	08	1659	2155	4078	7072	15676	23025
138	050	08	11	13	17	22	36	46
138	052	08	31	36	40	50	57	78
138	054	08	450	618	2189	5179	14423	21581
138	055	08	22	25	32	41	78	90
138	062	08	4371	5346	5525	7002	10215	12610
138	064	08	275	277	338	514	990	1344
138	066	08	5118	7431	8521	9192	10558	11183
138	068	08	2970	2786	2640	3026	4271	5079
138	115	08	343	405	558	785	1327	1712
140	066	08	10	24	39	42	52	60
141	052	08	10	30	41	45	57	62
141	064	08	45	143	282	340	488	592
141	066	08	0	71	169	173	191	212
144	068	08	30	31	33	38	53	61
915	047	08	21	27	48	68	124	169
915	068	08	11	22	30	34	45	52
		TOTAL	50639	63649	76647	94359	143240	181239

Note: BEA 915 refers to counties of BEA 115 which are origins and destinations of waterborne movements shipped to and from points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

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Table F-9. Ohio River System: BEA-to-BEA Waterborne Traffic of Feed and Food Products, Nec., Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
047	046	09	145	247	293	346	481	574
047	047	09	11	24	33	51	81	103
047	054	09	22	36	39	49	51	61
047	079	09	11	19	22	26	36	43
047	138	09	2941	5023	5950	7011	9761	11643
048	138	09	1458	1664	2057	2483	3458	4081
049	141	09	45	50	64	80	116	139
055	062	09	345	380	442	578	706	843
055	138	09	2232	2464	2857	3073	4647	5451
062	138	09	832	940	1132	1364	1937	2305
066	138	09	45	48	54	60	76	87
077	047	09	166	181	222	249	364	447
077	048	09	41	46	57	68	91	99
078	048	09	11	12	14	16	23	26
079	055	09	45	38	43	47	55	63
079	062	09	40	42	23	28	36	43
091	047	09	156	172	209	224	353	418
091	048	09	73	82	100	120	157	172
091	062	09	60	63	38	42	53	64
103	047	09	434	477	589	674	993	1187
108	047	09	134	148	182	209	306	367
111	055	09	11	9	11	11	15	17
111	062	09	67	74	41	59	63	77
111	066	09	45	48	55	62	78	88
113	062	09	272	296	172	179	270	308
114	062	09	469	508	294	318	453	539
114	066	09	412	446	488	550	692	781
133	048	09	11	12	14	16	23	26
137	047	09	20	23	27	31	45	55
138	047	09	642	700	867	1059	1459	1731
138	048	09	157	173	206	242	317	385
138	049	09	156	172	205	245	323	374
138	050	09	67	74	88	107	148	176
138	054	09	135	137	157	180	243	283
138	055	09	167	157	173	203	246	275
138	062	09	718	780	279	396	454	503
138	066	09	78	84	92	103	138	157
		TOTAL	12674	15849	17589	20559	28751	33991

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table F-10.Ohio River System: BEA-to-BEA Waterborne Traffic of Wood and Paper Products, Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
047	047	10	1861	1845	2359	2744	3574	4251
047	048	10	2148	2107	2436	2625	2580	2670
047	114	10	0	0	60	110	300	260
047	144	10	0	0	170	350	500	680
048	048	10	690	598	615	562	687	1043
048	107	10	11	12	23	34	54	67
048	114	10	11	11	13	21	37	57
048	144	10	67	66	79	106	151	223
050	048	10	434	506	983	1428	2476	3391
054	138	10	22	25	32	39	65	90
062	138	10	243	273	351	418	620	734
107	138	10	27	0	0	0	0	0
115	043	10	0	0	64	157	270	295
115	066	10	0	16	0	0	0	0
115	915	10	45	51	75	94	117	131
117	066	10	11	9	17	21	36	50
135	066	10	67	51	106	130	219	299
138	062	10	10	12	15	17	25	32
		TOTAL	5667	5582	7398	8856	11911	14323

Note: BEA 915 refers to counties of BEA 115 which are destinations of waterborne movements shipped to points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table F-11. Ohio River System: BEA-to-BEA Waterborne Traffic of Petroleum Products, Nec., Actual 1976 and Projectd 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	THOUSANDS OF TONS					
			1976	1980	1990	2000	2020	2040
038	050	11	56	58	98	112	96	71
046	049	11	156	173	273	297	249	175
047	052	11	32	38	59	55	42	23
047	066	11	78	63	98	136	126	106
047	141	11	63	65	100	109	91	63
052	049	11	110	279	386	353	266	143
052	052	11	120	953	1163	1054	838	519
052	054	11	350	598	832	825	642	350
052	062	11	550	1635	2125	1946	1506	844
052	064	11	90	0	536	508	392	225
052	066	11	1882	4375	6128	5650	4231	2232
052	068	11	500	0	0	0	0	0
052	077	11	60	183	248	223	167	90
052	137	11	11	16	25	25	21	14
052	138	11	61	186	253	228	169	92
052	141	11	270	286	602	421	305	340
054	049	11	50	34	55	64	58	44
054	054	11	20	30	48	62	55	40
062	054	11	840	1787	2517	2397	1848	1049
062	064	11	880	1872	2637	2512	1936	1120
062	066	11	420	514	785	891	764	557
064	066	11	116	0	281	318	271	198
066	046	11	31	44	67	70	57	39
066	052	11	271	399	545	569	428	237
066	062	11	40	51	80	93	79	58
066	066	11	11	12	21	32	47	62
066	138	11	844	1092	1815	1997	1680	1195
066	141	11	33	43	71	78	66	47
077	047	11	22	24	37	40	34	23
077	052	11	120	131	224	220	171	100
077	054	11	10	5	8	10	9	8
077	066	11	80	64	112	432	520	592
077	068	11	11	11	19	22	19	14
091	048	11	60	58	88	96	74	37
091	049	11	571	631	1002	1089	920	641
114	047	11	180	183	282	305	256	179
114	048	11	1439	1379	2055	2241	1884	1327
114	049	11	1006	748	1287	1527	1319	1024
114	050	11	1057	1534	2213	2403	2013	1417
114	054	11	390	195	319	397	397	303
114	062	11	722	723	1180	1474	1321	1040
114	064	11	150	156	262	300	257	189
114	066	11	1664	1612	3439	3974	3418	2526
115	114	11	33	0	0	0	0	0
137	048	11	400	408	772	837	700	492
137	062	11	910	915	1482	1744	1517	1144
138	048	11	120	114	155	164	138	96
138	049	11	961	832	1426	1661	1440	1079
138	054	11	1353	875	1515	1896	1706	1371
138	062	11	90	91	145	168	146	111
138	064	11	175	0	181	219	190	147
138	066	11	1313	2226	3558	3905	3261	2273
138	068	11	134	139	234	268	230	169
140	048	11	445	435	601	651	543	383
140	052	11	89	317	409	421	323	103
140	054	11	97	55	99	129	117	93
140	062	11	979	997	1617	1965	1739	1337
140	066	11	1583	1521	2922	3337	2884	2238
140	068	11	67	70	117	134	115	84
141	047	11	121	125	193	212	178	125
141	048	11	381	367	504	552	436	317
141	052	11	530	996	1404	1355	1047	606
141	054	11	415	237	413	526	474	388
141	062	11	359	362	586	706	622	478
141	064	11	130	0	397	479	423	325
141	066	11	1527	1377	2394	2917	2591	2028
141	068	11	283	294	495	565	495	357
144	047	11	11	11	18	19	15	11
		TOTAL	27933	35394	54011	60627	50584	35188

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table F-12.Ohio River System: BEA-TO-BEA Waterborne Traffic of Rubber, Plastic, Nonmetallic Minerals, Nec., Actual 1976 and Projected 1976-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
047	047	12	33	38	51	65	72	76
050	047	12	45	55	76	95	108	115
052	052	12	210	237	244	253	263	279
052	062	12	56	70	99	118	124	135
052	115	12	56	66	196	330	388	399
054	055	12	920	1084	1439	1859	1983	2041
054	115	12	22	22	32	41	42	43
054	133	12	122	141	198	235	276	300
054	135	12	56	65	91	113	132	144
055	062	12	22	46	65	80	96	105
055	133	12	22	31	44	54	64	69
062	047	12	0	0	0	0	600	1300
062	052	12	0	0	0	0	250	500
062	054	12	0	2314	3763	4570	4943	5153
062	055	12	0	10	15	18	20	31
062	064	12	0	939	1303	1358	2356	2941
062	066	12	285	1965	2716	3104	3912	3947
062	068	12	11	38	79	118	157	196
066	052	12	690	836	1031	1261	1472	1524
066	065	12	378	429	541	646	705	748
066	066	12	11	32	85	134	164	166
068	063	12	22	46	65	80	96	105
068	077	12	45	64	90	111	131	143
068	078	12	11	16	22	27	32	35
114	049	12	1636	2004	3092	4201	5111	5629
114	054	12	0	1429	2211	2256	3818	4707
114	055	12	85	330	670	846	2718	4208
114	062	12	1758	2224	3391	4469	6612	8141
114	066	12	11	11	17	20	24	35
115	046	12	1616	1734	2466	3175	3293	3360
115	047	12	80	93	142	197	244	251
115	049	12	680	690	742	823	899	949
115	054	12	270	366	392	404	447	490
115	055	12	690	713	847	1107	1232	1272
115	064	12	130	271	386	472	564	620
115	078	12	90	128	181	221	258	279
115	134	12	1313	1942	2749	3403	4010	4362
115	135	12	556	1060	1513	1833	2183	2368
137	062	12	33	52	77	96	130	162
141	068	12	11	17	26	32	45	55
915	054	12	0	102	154	203	329	471
915	064	12	11	17	26	32	43	54
915	066	12	545	851	1272	1583	2142	2683
915	068	12	1491	2327	3480	4330	5861	7340
915	115	12	690	825	1260	1514	1970	2270
		TOTAL	14713	25730	37339	45887	60319	70201

Note: BEA 915 refers to counties of BEA 115 which are origins of waterborne movements shipped from points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table F-13.Ohio River System: BEA-to-BEA Waterborne Traffic of Nonferrous Metals and Alloys, Nec., Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
049	066	13	22	19	94	122	230	362
049	140	13	78	118	227	375	745	1537
050	066	13	0	64	111	160	280	492
050	079	13	0	44	79	112	197	346
055	066	13	11	14	20	26	43	70
055	138	13	11	17	40	65	129	259
066	062	13	45	58	96	135	251	459
066	066	13	130	145	168	202	291	414
066	141	13	22	28	28	35	55	84
077	048	13	11	14	24	32	57	101
114	048	13	156	159	273	378	663	1199
114	052	13	56	66	75	96	147	236
114	055	13	33	171	260	351	609	1058
114	066	13	33	38	57	73	126	183
133	049	13	33	42	71	101	185	339
138	048	13	45	95	141	195	349	595
138	049	13	33	46	76	108	198	363
138	050	13	0	5	9	14	24	42
138	052	13	480	564	660	755	1490	2322
138	055	13	170	22	33	44	77	133
138	066	13	50	56	73	95	151	271
140	049	13	590	756	1268	1798	3299	6051
140	066	13	11	12	17	21	34	53
141	055	13	33	41	63	86	149	258
141	066	13	10	11	15	19	30	48
143	062	13	200	248	383	524	927	1636
143	066	13	140	156	212	269	429	684
144	062	13	33	36	45	51	66	84
144	066	13	33	41	65	89	156	276
		TOTAL	2469	3086	4632	6331	11387	19955

Source: Robert R. Nathan Associates, Inc.

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Table F-14. Ohio River System: BEA-to-BEA Waterborne Traffic of Manufactured Projects, Nec.
Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
038	048	14	11	13	20	26	51	68
045	048	14	22	25	23	31	51	81
045	068	14	11	20	17	23	36	45
046	066	14	11	20	25	31	46	56
047	138	14	200	205	217	249	304	198
047	141	14	22	45	135	261	725	1320
048	077	14	11	24	53	86	178	264
048	138	14	56	84	115	168	321	367
049	052	14	0	59	264	559	1141	1500
049	115	14	801	591	519	678	903	999
049	138	14	0	459	883	1410	2992	4598
049	140	14	33	47	78	119	230	326
050	045	14	22	31	46	68	121	163
050	065	14	11	11	15	22	40	55
050	112	14	11	15	24	35	67	92
052	049	14	11	15	25	33	62	85
052	133	14	11	22	37	57	92	117
052	135	14	11	14	22	32	57	77
054	138	14	400	553	862	1276	2425	3366
055	138	14	11	20	18	24	44	59
062	066	14	11	17	17	18	13	13
064	066	14	11	13	19	24	41	54
066	045	14	33	60	172	260	492	687
066	054	14	20	23	35	51	95	131
066	055	14	53	64	93	127	221	251
066	062	14	60	73	97	137	223	293
066	064	14	42	51	76	112	208	285
066	066	14	618	1031	1094	1158	1399	1585
066	135	14	10	18	23	29	41	50
066	138	14	91	273	300	441	499	521
066	141	14	83	279	374	516	789	877
066	144	14	11	20	25	31	46	57
068	066	14	10	12	16	20	32	40
068	141	14	22	57	94	141	265	374
077	050	14	11	12	16	22	36	48
077	064	14	22	40	50	63	91	111
077	068	14	11	12	16	22	36	48
114	066	14	10	20	50	60	120	190
114	115	14	100	75	82	113	166	168
117	047	14	11	13	19	30	62	90
119	064	14	11	11	22	33	68	91
119	115	14	11	9	11	12	13	14
138	047	14	11	11	13	17	29	29
138	048	14	22	22	29	34	61	61
138	049	14	11	13	17	23	41	41
138	052	14	411	368	292	187	83	65
138	055	14	22	22	30	44	86	145
138	066	14	0	72	276	570	1149	1516
140	049	14	111	123	162	218	367	480
		TOTAL	3516	5087	7018	9701	15658	22163

Source: Robert R. Nathan Associates, Inc.

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Table F-15. Ohio River System: BEA-to-BEA Waterborne Traffic of Others, Nec., Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
047	141	15	11	11	12	13	14	14
049	091	15	111	116	122	118	127	146
049	115	15	11	13	14	13	13	13
049	138	15	89	99	120	113	112	102
052	052	15	33	47	49	53	64	71
052	066	15	78	90	103	116	155	178
052	114	15	45	52	48	57	75	103
054	062	15	11	6	11	10	9	5
055	064	15	30	27	92	84	35	26
055	077	15	89	100	113	103	92	73
062	066	15	420	470	273	315	480	601
064	052	15	240	263	285	279	263	235
066	046	15	40	42	43	43	42	41
066	062	15	20	20	18	19	27	45
066	064	15	671	562	503	560	715	846
066	066	15	20	21	26	27	33	37
066	114	15	11	12	9	9	12	15
066	115	15	21	62	53	44	44	39
066	138	15	32	36	0	0	0	0
068	115	15	90	99	107	105	99	88
114	055	15	234	266	285	311	359	354
115	038	15	56	59	61	60	59	58
115	046	15	3795	3981	3624	3681	3818	4000
115	055	15	67	47	48	38	30	29
115	064	15	90	95	96	96	97	100
115	066	15	10	11	16	16	16	15
115	115	15	4763	5054	5082	5077	5149	5273
115	132	15	4440	4711	4809	4777	4693	4587
115	133	15	4318	4564	4564	4555	4543	4543
115	134	15	2003	2115	2115	2113	2109	2107
115	135	15	434	459	459	458	457	457
115	137	15	130	138	138	138	135	135
115	138	15	15311	16245	16658	16551	16230	15801
115	140	15	67	70	70	70	70	70
115	915	15	4363	4612	4612	4603	4594	4590
117	047	15	22	23	23	26	27	28
119	115	15	22	33	33	33	32	32
137	055	15	11	22	24	31	42	42
138	049	15	378	395	412	445	484	495
138	052	15	11	60	47	76	88	100
138	054	15	11	11	11	12	14	14
138	055	15	10	18	18	21	25	23
138	062	15	56	352	187	211	453	533
138	064	15	89	244	45	115	322	262
138	115	15	0	718	505	781	1441	2385
140	066	15	67	76	76	82	99	108
141	052	15	352	553	365	533	989	1748
141	066	15	11	35	38	53	91	125
141	115	15	0	1090	715	965	1509	2435
		TOTAL	47194	48117	47137	48011	50786	51427

Note: BEA 915 refers to counties of BEA 115 which are destinations of waterborne movements shipped to points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

APPENDIX G

BEST DOCUMENT AVAILABLE

Table G-1. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	1,070,817	1,167,818	1,603,497	1,895,238	2,383,408	2,820,619
Opekiska L/D	188	208	256	290	324	360
Hildebrand L/D	1,548	1,657	2,009	2,161	2,276	2,397
Morgantown L/D	2,344	2,605	3,358	3,726	4,104	4,376
Point Marion L/D	6,991	7,622	9,300	10,332	11,115	11,808
L/D 7 - Monongahela	8,939	9,689	11,608	12,861	13,856	14,759
Maxwell L/D	18,364	19,734	22,737	25,297	28,369	31,299
L/D 4 - Monongahela	19,351	20,836	23,732	26,302	29,475	32,478
L/D 3 - Monongahela	25,101	27,275	30,876	33,946	37,971	41,436
L/D 2 - Monongahela	22,885	25,846	30,627	34,188	41,314	46,767
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	126	137	104	91	101	107
L/D 5 - Allegheny	1,625	1,773	1,377	1,229	1,374	1,452
L/D 4 - Allegheny	2,145	2,342	2,155	2,157	2,462	2,655
L/D 3 - Allegheny	3,789	4,202	4,786	5,417	6,430	7,140
L/D 2 - Allegheny	4,241	4,677	5,286	5,989	7,137	7,986
Emsworth L/D	25,811	29,119	36,092	41,446	50,144	56,587
Dashields L/D	25,587	28,769	35,428	40,609	49,062	55,324
Montgomery L/D	22,936	26,424	33,314	38,494	48,157	55,155
New Cumberland L/D	26,583	30,380	38,067	43,818	54,603	62,451
Pike Island L/D	27,079	31,411	41,249	48,121	61,610	71,247
Hannibal L/D	31,603	36,054	48,118	56,048	71,884	83,251
Willow Island L/D	33,021	37,844	51,248	60,851	80,830	95,454
Belleville L/D	34,642	40,008	56,175	67,185	88,612	104,338
Racine L/D	36,234	42,156	58,087	68,900	90,105	105,746
London L/D	1,604	1,919	3,035	3,224	3,209	3,196
Harmet L/D	6,619	8,010	12,330	13,215	13,382	13,814
Winfield L/D	11,344	13,553	19,403	21,977	26,483	29,810
Gallipolis L/D	40,794	47,538	64,519	75,000	93,475	107,916
Greenup L/D	32,388	36,041	48,668	59,833	72,473	86,123
Meldahl L/D	28,708	32,162	42,843	52,521	65,961	79,158
Markland L/D	34,160	38,570	53,729	65,690	85,723	103,764
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	542	546	521	471	561	610
L/D 3	542	546	521	471	561	610
L/D 2	542	546	521	471	561	610
L/D 1	542	546	521	471	561	610
McAlpine L/D	40,094	44,493	63,218	78,086	104,179	127,807
Cannelton L/D	42,787	46,495	66,056	81,706	109,698	135,016
Newburgh L/D	39,854	42,247	68,874	84,565	117,194	146,698
L/D 3	58	67	85	134	74	59
L/D 2	12,417	14,062	22,845	25,652	24,829	25,736
L/D 1	12,958	14,685	23,871	26,758	26,650	27,918
Uniontown L/D	47,126	48,519	72,876	87,149	111,715	137,575
L/D 50 - Ohio River	51,895	53,459	79,092	92,955	115,885	140,594
L/D 51 - Ohio River	52,743	54,267	79,950	93,152	116,654	141,783
Smithland L/D	52,913	54,520	80,184	93,407	116,963	142,103

(continued)

Table G-1. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 52 - Ohio River	61,530	62,460	94,712	116,207	146,489	178,250
L/D 53 - Ohio River	56,110	55,009	75,447	94,522	117,641	143,672
Kentucky - Barkley L/D	24,719	27,405	31,336	33,537	42,648	47,765
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	262	276	351	465	650	707
Cheatham L/D	3,791	3,609	4,476	5,250	6,605	7,410
Watts bar L/D	378	472	668	830	1,128	1,338
Chickamauga L/D	973	1,438	1,444	1,705	2,213	2,494
Nickajack L/D	4,029	4,173	5,496	6,447	7,620	8,139
Guntersville L/D	4,544	4,824	6,478	7,798	9,907	11,063
Wheeler L/D	6,996	7,532	10,228	12,835	18,221	22,062
Wilson L/D	7,301	7,895	10,847	13,747	19,887	24,391
Pickwick L/D	8,191	8,850	11,950	15,048	21,760	26,657
Ft. Loudoun L/D	228	312	407	473	514	503
Melton Hill L/D	4	6	9	13	23	31

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

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Table G-2. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group I: Coal and Coke

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	533,241	594,408	872,414	1,000,996	1,235,851	1,480,004
Opekiska L/D	100	108	130	143	151	160
Hildebrand L/D	1,460	1,557	1,883	2,014	2,103	2,197
Morgantown L/D	1,586	1,693	2,050	2,196	2,296	2,401
Point Marion L/D	5,935	6,437	7,672	8,454	9,012	9,616
L/D 7 - Monongahela	7,882	8,503	9,979	10,983	11,753	12,573
Maxwell L/D	17,307	18,547	21,108	23,419	26,266	29,113
L/D 4 - Monongahela	17,530	18,781	21,353	23,687	26,564	29,440
L/D 3 - Monongahela	21,213	22,648	25,291	28,087	31,882	35,622
L/D 2 - Monongahela	17,313	19,350	22,934	25,841	32,239	37,624
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	208	217	233	265	313	361
L/D 3 - Allegheny	2,012	2,120	2,289	2,567	2,994	3,435
L/D 2 - Allegheny	2,463	2,593	2,786	3,136	3,697	4,277
Emsworth L/D	15,947	17,942	21,465	24,437	31,457	37,454
Dashields L/D	15,947	17,942	21,465	24,437	31,457	37,454
Montgomery L/D	11,500	13,318	16,517	19,236	26,619	32,929
New Cumberland L/D	14,110	16,204	19,862	22,857	30,985	37,772
Pike Island L/D	15,279	17,874	22,891	26,636	37,357	45,892
Hannibal L/D	17,615	20,527	27,820	32,316	44,081	53,452
Willow Island L/D	17,616	20,528	27,826	32,323	44,091	53,464
Belleville L/D	18,290	21,368	30,618	35,658	48,317	58,492
Racine L/D	18,292	21,370	30,622	35,663	48,322	58,497
London L/D	1,265	1,560	2,613	2,811	2,781	2,800
Marmet L/D	5,195	6,335	10,173	11,155	11,219	11,625
Winfield L/D	4,221	5,114	9,133	10,307	11,217	12,310
Gallipolis L/D	22,149	25,941	36,009	42,426	55,791	67,547
Greenup L/D	13,721	14,823	21,779	28,315	35,120	45,176
Meldahl L/D	9,546	10,327	15,203	20,128	27,502	36,536
Markland L/D	11,670	14,041	22,212	27,335	38,059	48,626
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	18,340	21,759	34,071	41,849	57,471	62,647
Cannelton L/D	20,011	23,723	37,017	45,485	62,448	78,845
Newburgh L/D	15,311	17,733	36,840	44,442	62,272	79,829
L/D 3	58	67	85	134	74	59
L/D 2	12,241	13,904	22,645	25,377	24,517	25,387
L/D 1	12,778	14,523	23,665	26,472	26,318	27,543
Uniontown L/D	19,956	21,991	39,342	43,427	52,466	64,434

(continued)

Table G-2. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	24,458	26,788	45,359	48,949	56,261	66,975
L/D 51 - Ohio River	24,548	26,868	45,430	49,040	56,380	67,137
Smithland L/D	24,548	26,868	45,430	49,040	56,380	67,137
L/D 52 - Ohio River	19,805	19,668	42,842	50,064	57,546	69,879
L/D 53 - Ohio River	15,167	12,988	24,657	29,152	29,802	36,576
Kentucky - Barkley L/D	11,018	12,653	12,111	9,951	8,897	6,143
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	—	—	—	—	—	—
Watts Bar L/D	—	—	—	—	—	—
Chickamauga L/D	198	567	271	208	213	112
Nickajack L/D	1,104	968	1,410	1,790	1,951	1,900
Guntersville L/D	1,109	975	1,415	1,794	1,955	1,902
Wheeler L/D	1,577	1,388	1,855	2,235	2,343	2,179
Wilson L/D	1,632	1,434	1,901	2,283	2,385	2,211
Pickwick L/D	2,009	1,776	2,152	2,473	2,529	2,270
Ft. Loudoun L/D	—	—	—	—	—	—
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

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Table C-3. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group II: Petroleum Fuels

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	154,487	134,128	151,425	179,671	152,755	122,658
Opekiska L/D	—	—	—	—	—	—
Hildebrand L/D	—	—	—	—	—	—
Morgantown L/D	—	—	—	—	—	—
Point Marion L/D	295	270	315	341	286	199
L/D 7 - Monongahela	295	270	315	341	286	199
Maxwell L/D	295	270	315	341	286	199
L/D 4 - Monongahela	393	378	451	492	412	295
L/D 3 - Monongahela	1,350	1,533	2,113	2,071	1,634	895
L/D 2 - Monongahela	1,772	1,890	2,490	2,568	2,080	1,270
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	30	15	11	23	22	21
L/D 3 - Allegheny	157	107	91	152	147	138
L/D 2 - Allegheny	157	107	91	152	147	138
Emsworth L/D	3,026	2,863	3,440	3,939	3,343	2,416
Dashields L/D	3,172	2,988	3,607	4,097	3,468	2,491
Montgomery L/D	3,446	3,393	4,264	4,647	3,854	2,613
New Cumberland L/D	3,949	3,910	4,896	5,306	4,392	2,983
Pike Island L/D	4,327	4,308	5,403	5,853	4,839	3,346
Hannibal L/D	4,365	4,309	5,372	5,854	4,854	3,384
Willow Island L/D	4,357	4,309	5,374	5,849	4,844	3,384
Belleville L/D	5,007	4,966	6,300	6,856	5,682	3,976
Racine L/D	5,007	4,966	6,300	6,856	5,682	3,976
London L/D	197	196	235	202	153	45
Marmet L/D	660	784	1,185	988	734	444
Winfield L/D	1,280	1,612	2,210	2,007	1,505	833
Gallipolis L/D	6,471	6,912	9,219	9,306	7,470	4,809
Greenup L/D	6,599	6,839	8,029	8,564	7,201	5,067
Meldahl L/D	6,661	6,820	7,966	8,491	7,152	5,306
Markland L/D	6,832	5,882	6,872	7,746	6,598	5,265
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	3	3	4	4	3	2
L/D 3	3	3	4	4	3	2
L/D 2	3	3	4	4	3	2
L/D 1	3	3	4	4	3	2
McAlpine L/D	7,374	5,867	6,704	7,794	6,806	5,571
Cannelton L/D	7,649	5,175	5,897	6,899	6,184	5,218
Newburgh L/D	7,860	5,358	6,172	7,196	6,406	5,282
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
Uniontown L/D	8,370	6,141	5,725	8,258	7,206	7,131

(continued)

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Table G-3. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	8,370	6,141	5,725	8,258	7,206	7,131
L/D 51 - Ohio River	8,370	6,141	5,725	8,258	7,206	7,131
Smithland L/D	8,370	6,141	5,725	8,258	7,206	7,131
L/D 52 - Ohio River	10,094	7,514	6,410	10,397	9,166	8,993
L/D 53 - Ohio River	10,094	7,514	6,410	10,397	9,166	8,993
Kentucky - Barkley L/D	2,395	2,526	3,135	3,351	2,803	1,953
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	96	106	118	140	115	70
Cheatham L/D	1,281	1,335	1,585	1,811	1,512	1,080
Watts Bar L/D	38	40	48	51	44	30
Chickamauga L/D	164	148	146	198	178	140
Nickajack L/D	515	553	690	724	603	412
Guntersville L/D	599	657	835	852	703	475
Wheeler L/D	822	859	1,041	1,130	949	668
Wilson L/D	829	865	1,047	1,138	957	674
Pickwick L/D	1,051	1,099	1,361	1,453	1,215	848
Ft. Loudoun L/D	38	40	48	51	44	30
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

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Table G-4. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group III: Crude Petroleum

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	5,522	8,240	6,047	5,053	4,326	2,518
Opekiska L/D	—	—	—	—	—	—
Hildebrand L/D	—	—	—	—	—	—
Morgantown L/D	—	—	—	—	—	—
Point Marion L/D	—	—	—	—	—	—
L/D 7 - Monongahela	—	—	—	—	—	—
Maxwell L/D	—	—	—	—	—	—
L/D 4 - Monongahela	—	—	—	—	—	—
L/D 3 - Monongahela	—	—	—	—	—	—
L/D 2 - Monongahela	—	—	—	—	—	—
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	3	6	2	2	2	1
L/D 3 - Allegheny	3	6	2	2	2	1
L/D 2 - Allegheny	3	6	2	2	2	1
Emsworth L/D	3	6	2	2	2	1
Dashields L/D	3	6	2	2	2	1
Montgomery L/D	3	6	2	2	2	1
New Cumberland L/D	3	6	2	2	2	1
Pike Island L/D	3	6	2	2	2	1
Hannibal L/D	3	6	2	2	2	1
Willow Island L/D	3	6	2	2	2	1
Belleville L/D	167	344	118	111	85	49
Racine L/D	167	344	118	111	85	49
London L/D	—	—	—	—	—	—
Marmet L/D	—	—	—	—	—	—
Winfield L/D	—	—	—	—	—	—
Gallipolis L/D	167	344	118	111	85	49
Greenup L/D	167	344	118	111	85	49
Meldahl L/D	167	344	118	111	85	49
Markland L/D	167	344	118	111	85	49
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	167	344	118	111	85	49
Cannelton L/D	167	344	118	111	85	49
Newburgh L/D	167	344	118	111	85	49
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
Uniontown L/D	665	847	827	773	591	344

(continued)

Table G-4. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	665	847	827	773	591	344
L/D 51 - Ohio River	665	847	827	773	591	344
Smithland L/D	665	847	827	773	591	344
L/D 52 - Ohio River	665	847	827	773	591	344
L/D 53 - Ohio River	665	847	827	773	591	344
Kentucky - Barkley L/D	—	—	—	—	—	—
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	—	—	—	—	—	—
Watts Bar L/D	—	—	—	—	—	—
Chickamauga L/D	—	—	—	—	—	—
Nickajack L/D	—	—	—	—	—	—
Guntersville L/D	—	—	—	—	—	—
Wheeler L/D	—	—	—	—	—	—
Wilson L/D	—	—	—	—	—	—
Pickwick L/D	—	—	—	—	—	—
Ft. Loudoun L/D	—	—	—	—	—	—
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

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Table G-5. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group IV: Aggregates

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	47,433	54,463	82,737	100,637	114,835	122,394
Opekiska L/D	—	—	—	—	—	—
Hildebrand L/D	—	—	—	—	—	—
Morgantown L/D	670	812	1,182	1,382	1,635	1,776
Point Marion L/D	672	815	1,186	1,387	1,640	1,781
L/D 7 - Monongahela	673	816	1,187	1,387	1,641	1,782
Maxwell L/D	673	816	1,187	1,387	1,641	1,782
L/D 4 - Monongahela	1,009	1,182	1,463	1,630	1,911	2,067
L/D 3 - Monongahela	1,056	1,232	1,502	1,664	1,948	2,107
L/D 2 - Monongahela	1,276	1,472	1,683	1,822	2,125	2,293
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	126	137	104	91	101	107
L/D 5 - Allegheny	1,625	1,773	1,377	1,229	1,374	1,452
L/D 4 - Allegheny	1,625	1,773	1,377	1,229	1,374	1,452
L/D 3 - Allegheny	598	656	535	492	552	586
L/D 2 - Allegheny	598	656	535	492	552	586
Emsworth L/D	2,247	2,536	4,056	4,919	5,396	5,646
Dashields L/D	1,833	2,008	3,128	3,781	4,039	4,167
Montgomery L/D	2,045	2,236	3,313	3,943	4,215	4,352
New Cumberland L/D	1,739	1,900	2,953	3,584	3,794	3,896
Pike Island L/D	304	338	1,740	2,497	2,573	2,602
Hannibal L/D	1,790	1,614	2,846	3,636	4,288	4,645
Willow Island L/D	1,409	1,185	2,682	3,664	4,414	4,818
Belleville L/D	781	494	2,335	3,833	4,634	5,059
Racine L/D	2,297	2,553	4,131	5,398	5,852	6,115
London L/D	46	53	53	53	55	57
Marmet L/D	120	130	131	129	133	135
Winfield L/D	2,080	2,246	2,265	2,240	2,310	2,332
Gallipolis L/D	2,192	2,182	3,739	4,966	5,366	5,567
Greenup L/D	1,942	1,809	3,350	4,565	4,940	5,115
Meldahl L/D	2,184	2,252	3,901	5,150	5,666	5,918
Markland L/D	1,450	2,093	3,845	5,242	5,939	6,322
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	539	543	517	467	557	608
L/D 3	539	543	517	467	557	608
L/D 2	539	543	517	467	557	608
L/D 1	539	543	517	467	557	608
McAlpine L/D	156	504	1,727	2,851	3,111	3,258
Cannelton L/D	493	889	1,908	3,023	3,325	3,493
Newburgh L/D	545	883	1,696	2,200	2,489	2,647
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
Uniontown L/D	77	465	1,321	1,848	2,051	2,153

(continued)

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Table C-5. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	77	465	1,321	1,848	2,051	2,153
L/D 51 - Ohio River	753	1,117	1,923	1,673	2,150	2,391
Smithland L/D	753	1,117	1,923	1,673	2,150	2,391
L/D 52 - Ohio River	2,079	3,215	3,794	3,619	4,456	4,909
L/D 53 - Ohio River	1,336	2,486	2,724	2,840	3,359	3,647
Kentucky - Barkley L/D	1,904	1,589	1,790	1,935	2,524	2,855
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	1,392	982	944	852	1,202	1,406
Watts Bar L/D	12	24	11	21	34	40
Chickamauga L/D	2	13	6	17	29	34
Nickajack L/D	436	481	630	730	938	1,046
Guntersville L/D	78	90	262	407	582	655
Wheeler L/D	12	21	270	437	621	718
Wilson L/D	12	21	270	437	621	718
Pickwick L/D	88	137	352	547	772	898
Ft. Loudoun L/D	12	24	11	21	39	40
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table G-6. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group V: Grains

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	40,273	30,887	37,155	44,396	53,280	62,859
Opekiska L/D	—	—	—	—	—	—
Hildebrand L/D	—	—	—	—	—	—
Morgantown L/D	—	—	—	—	—	—
Point Marion L/D	—	—	—	—	—	—
L/D 7 - Monongahela	—	—	—	—	—	—
Maxwell L/D	—	—	—	—	—	—
L/D 4 - Monongahela	—	—	—	—	—	—
L/D 3 - Monongahela	—	—	—	—	—	—
L/D 2 - Monongahela	—	—	—	—	—	—
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	—	—	—	—	—	—
L/D 3 - Allegheny	—	—	—	—	—	—
L/D 2 - Allegheny	—	—	—	—	—	—
Emsworth L/D	—	—	—	—	—	—
Dashields L/D	—	—	—	—	—	—
Montgomery L/D	—	—	—	—	—	—
New Cumberland L/D	—	—	—	—	—	—
Pike Island L/D	—	—	—	—	—	—
Hannibal L/D	—	—	—	—	—	—
Willow Island L/D	—	—	—	—	—	—
Belleville L/D	2	2	2	3	3	3
Racine L/D	2	2	2	3	3	3
London L/D	—	—	—	—	—	—
Marmet L/D	—	—	—	—	—	—
Winfield L/D	—	—	—	—	—	—
Gallipolis L/D	2	2	2	3	3	3
Greenup L/D	3	2	3	4	5	5
Meldahl L/D	4	3	4	5	6	6
Markland L/D	1,545	1,253	1,655	2,074	2,524	2,985
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	1,611	1,307	1,717	2,151	2,634	3,129
Cannelton L/D	1,611	1,307	1,717	2,151	2,634	3,129
Newburgh L/D	1,763	1,373	1,810	2,283	2,818	3,371
L/D 3	—	—	—	—	—	—
L/D 2	176	159	200	276	312	349
L/D 1	176	159	200	276	312	349
Uniontown L/D	3,634	2,368	3,130	4,089	5,210	6,431

(continued)

BEST DOCUMENT AVAILABLE

Table G-6. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	3,901	2,510	3,329	4,373	5,584	6,910
L/D 51 - Ohio River	3,951	2,536	3,362	4,420	5,649	6,995
Smithland L/D	3,951	2,536	3,362	4,420	5,649	6,995
L/D 52 - Ohio River	5,238	3,896	4,656	5,572	6,718	7,978
L/D 53 - Ohio River	5,238	3,896	4,656	5,572	6,718	7,978
Kentucky - Barkley L/D	1,411	1,423	1,382	1,266	1,224	1,177
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	—	—	—	—	—	—
Watts Bar L/D	14	18	17	16	16	15
Chickamauga L/D	14	18	17	16	16	15
Nickajack L/D	718	752	741	684	665	638
Guntersville L/D	1,101	1,117	1,082	1,003	977	945
Wheeler L/D	1,397	1,410	1,361	1,237	1,191	1,141
Wilson L/D	1,397	1,410	1,361	1,237	1,191	1,141
Pickwick L/D	1,400	1,413	1,369	1,248	1,203	1,154
Ft. Loudoun L/D	14	18	17	16	16	15
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table G-7. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group VI: Chemicals and Chemical Fertilizers

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	92,806	99,517	128,776	171,299	290,418	385,599
Opekiska L/D	—	—	—	—	—	—
Hildebrand L/D	—	—	—	—	—	—
Morgantown L/D	—	—	—	—	—	—
Point Marion L/D	—	—	—	—	—	—
L/D 7 - Monongahela	—	—	—	—	—	—
Maxwell L/D	—	—	—	—	—	—
L/D 4 - Monongahela	35	39	50	66	102	130
L/D 3 - Monongahela	67	77	97	129	207	263
L/D 2 - Monongahela	306	362	492	681	1,124	1,473
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	—	—	—	—	—	—
L/D 3 - Allegheny	88	92	108	136	222	277
L/D 2 - Allegheny	88	92	108	136	222	277
Emsworth L/D	595	657	820	1,081	1,778	2,285
Dashields L/D	585	645	803	1,059	1,744	2,241
Montgomery L/D	1,182	1,293	1,588	2,078	3,413	4,358
New Cumberland L/D	1,255	1,372	1,693	2,218	3,646	4,661
Pike Island L/D	1,315	1,443	1,784	2,337	3,863	4,950
Hannibal L/D	1,866	2,029	2,513	3,291	5,496	7,092
Willow Island L/D	3,717	4,276	5,836	8,102	14,357	19,153
Belleville L/D	3,892	4,472	6,123	8,510	15,082	20,135
Racine L/D	3,892	4,472	6,123	8,510	15,082	20,135
London L/D	1	1	1	1	1	a
Marmet L/D	490	549	562	608	835	1,008
Winfield L/D	3,331	3,904	4,898	6,409	10,205	12,883
Gallipolis L/D	3,052	3,334	4,082	5,190	8,791	11,865
Greenup L/D	3,193	3,471	4,169	5,271	8,866	12,011
Meldahl L/D	3,159	3,417	4,084	5,149	8,656	11,697
Markland L/D	4,179	4,513	5,577	7,178	12,063	16,122
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	4,244	4,582	5,680	7,320	12,309	16,438
Cannelton L/D	4,403	4,747	5,914	7,646	12,865	17,179
Newburgh L/D	4,878	5,045	6,344	8,232	13,799	18,369
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	3	2	3	4	7	9
Uniontown L/D	5,163	5,233	6,614	8,602	14,399	19,144

(continued)

BEST DOCUMENT AVAILABLE

Table C-7. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	5,163	5,233	6,614	8,602	14,399	19,144
L/D 51 - Ohio River	5,163	5,233	6,614	8,602	14,399	19,144
Smithland L/D	5,163	5,233	6,614	8,602	14,399	19,144
L/D 52 - Ohio River	7,248	7,416	9,550	12,589	20,020	25,676
L/D 53 - Ohio River	7,248	7,416	9,550	12,589	20,020	25,676
Kentucky - Barkley L/D	2,214	2,461	3,794	5,590	10,354	14,284
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	166	170	233	325	535	700
Cheatham L/D	213	215	291	400	651	847
Watts Bar L/D	18	18	27	36	65	87
Chickamauga L/D	52	63	93	136	251	341
Nickajack L/D	132	158	238	344	634	864
Guntersville L/D	366	435	641	910	1,645	2,237
Wheeler L/D	1,478	1,681	2,647	3,944	7,449	10,363
Wilson L/D	1,547	1,768	2,794	4,175	7,906	11,010
Pickwick L/D	1,645	1,881	2,992	4,482	8,507	11,860
Ft. Loudoun L/D	16	16	22	31	54	71
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

a: Less than 500 tons.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table G-8. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group VII: Ores and Minerals

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	50,384	58,891	83,262	110,015	176,791	244,409
Opekiska L/D	50	57	72	83	102	125
Hildebrand L/D	50	57	72	83	102	125
Morgantown L/D	50	57	72	83	102	125
Point Marion L/D	50	57	72	83	102	125
L/D 7 - Monongahela	50	57	72	83	102	125
Maxwell L/D	50	57	72	83	102	125
L/D 4 - Monongahela	50	57	72	83	102	125
L/D 3 - Monongahela	303	334	384	448	586	733
L/D 2 - Monongahela	459	498	557	643	828	1,029
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	5	6	7	8	12	15
L/D 3 - Allegheny	316	355	445	542	794	953
L/D 2 - Allegheny	316	355	445	542	794	953
Emsworth L/D	888	972	1,125	1,323	1,791	2,191
Dashields L/D	888	972	1,125	1,323	1,791	2,191
Montgomery L/D	916	1,006	1,173	1,383	1,882	2,304
New Cumberland L/D	1,026	1,127	1,338	1,603	2,245	2,931
Pike Island L/D	1,068	1,173	1,396	1,673	2,347	3,054
Hannibal L/D	1,132	1,241	1,465	1,750	2,441	3,171
Willow Island L/D	1,132	1,241	1,465	1,750	2,441	3,171
Belleville L/D	1,465	1,607	1,901	2,286	3,219	4,243
Racine L/D	1,465	1,607	1,901	2,286	3,219	4,243
London L/D	61	71	92	117	176	253
Marmet L/D	108	129	182	237	372	539
Winfield L/D	169	211	308	409	652	933
Gallipolis L/D	1,609	1,796	2,206	2,705	3,927	5,226
Greenup L/D	1,652	1,850	2,289	2,816	4,108	5,490
Meldahl L/D	1,796	2,020	2,522	3,113	4,555	6,173
Markland L/D	2,340	2,658	3,396	4,208	6,131	8,528
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	2,421	2,754	3,524	4,370	6,367	8,854
Cannelton L/D	2,421	2,754	3,524	4,370	6,367	8,854
Newburgh L/D	3,034	3,689	5,627	7,738	13,053	18,348
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	1	2	3	6	12	17
Uniontown L/D	3,056	3,724	5,723	7,873	13,327	18,736

(continued)

Table G-8. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	3,056	3,724	5,723	7,873	13,327	18,736
L/D 51 - Ohio River	3,078	3,763	5,861	8,094	13,802	19,430
Smithland L/D	3,078	3,763	5,861	8,094	13,802	19,430
L/D 52 - Ohio River	4,230	5,152	8,120	11,322	19,405	27,313
L/D 53 - Ohio River	4,230	5,152	8,120	11,322	19,405	27,313
Kentucky - Barkley L/D	841	1,027	1,819	2,680	4,823	6,903
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	49	55	81	116	195	304
Watts Bar L/D	72	80	131	184	314	430
Chickamauga L/D	161	189	332	475	839	1,157
Nickajack L/D	161	189	332	475	839	1,157
Guntersville L/D	162	190	334	478	844	1,164
Wheeler L/D	163	192	337	482	851	1,175
Wilson L/D	323	396	722	1,053	1,904	2,669
Pickwick L/D	376	465	851	1,245	2,259	3,173
Ft. Loudoun L/D	7	8	14	20	34	45
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

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Table G-9. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group VIII: Iron Ore Steel and Iron

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	74,619	94,061	109,733	129,280	180,170	218,791
Opekiska L/D	—	—	—	—	—	—
Hildebrand L/D	—	—	—	—	—	—
Morgantown L/D	—	—	—	—	—	—
Point Marion L/D	—	—	—	—	—	—
L/D 7 - Monongahela	—	—	—	—	—	—
Maxwell L/D	—	—	—	—	—	—
L/D 4 - Monongahela	282	340	270	257	280	306
L/D 3 - Monongahela	935	1,156	1,095	1,143	1,338	1,506
L/D 2 - Monongahela	1,476	1,856	1,862	1,983	2,330	2,610
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	100	141	221	279	415	528
L/D 3 - Allegheny	194	277	393	467	644	785
L/D 2 - Allegheny	195	279	396	470	648	789
Emsworth L/D	2,009	2,601	2,834	3,086	3,741	4,263
Dashields L/D	2,017	2,610	2,846	3,098	3,757	4,281
Montgomery L/D	2,552	3,275	3,574	3,911	4,795	5,480
New Cumberland L/D	2,931	3,646	3,944	4,346	5,393	6,181
Pike Island L/D	3,097	3,873	4,394	4,941	6,212	7,156
Hannibal L/D	3,143	3,928	4,454	5,006	6,296	7,252
Willow Island L/D	3,153	3,939	4,466	5,023	6,321	7,283
Belleville L/D	3,219	4,017	4,583	5,175	6,574	7,610
Racine L/D	3,220	4,018	4,584	5,177	6,576	7,613
London L/D	10	12	12	13	17	18
Marmet L/D	10	12	12	13	17	18
Winfield L/D	30	37	39	42	52	57
Gallipolis L/D	3,233	4,033	4,609	5,209	6,619	7,662
Greenup L/D	3,299	4,113	4,726	5,357	6,843	7,935
Meldahl L/D	3,405	4,246	4,870	5,546	7,135	8,300
Markland L/D	3,536	4,416	5,059	5,861	7,662	9,007
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	3,285	4,123	4,878	5,904	8,623	10,643
Cannelton L/D	3,284	4,112	4,876	5,902	8,620	10,641
Newburgh L/D	3,273	4,110	4,863	5,888	8,606	10,629
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
Uniontown L/D	3,210	4,041	4,783	5,802	8,556	10,598

(continued)

BEST DOCUMENT AVAILABLE

Table G-9. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	3,210	4,041	4,783	5,802	8,556	10,598
L/D 51 - Ohio River	3,210	4,041	4,783	5,802	8,556	10,598
Smithland L/D	3,210	4,041	4,783	5,802	8,556	10,598
L/D 52 - Ohio River	3,543	4,547	5,637	7,142	11,324	14,622
L/D 53 - Ohio River	3,542	4,546	5,636	7,140	11,321	14,619
Kentucky - Barkley L/D	821	1,075	1,691	2,433	4,513	6,194
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	300	401	642	884	1,560	2,102
Watts Bar L/D	21	24	31	38	56	67
Chickamauga L/D	21	24	31	38	56	67
Nickajack L/D	124	151	200	263	422	542
Guntersville L/D	295	373	534	736	1,258	1,623
Wheeler L/D	373	482	708	998	1,776	2,397
Wilson L/D	388	502	743	1,051	1,882	2,547
Pickwick L/D	443	572	858	1,219	2,222	3,020
Ft. Loudoun L/D	18	21	27	32	44	51
Melton Hill L/D	—	—	—	—	—	—

Note: Tonnages may not sum to totals due to rounding.

Source: Robert R. Nathan Associates, Inc.

BEST DOCUMENT AVAILABLE

Table G-10. Ohio River Basin: Total Waterborne Commerce by Lock and Dam, 1976 and Projected 1980-2040, Selected Years

Group IX-XV[a]

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL	72,054	93,223	131,948	153,292	174,982	181,386
Opekiska L/D	38	43	54	65	71	75
Hildebrand L/D	38	43	54	65	71	75
Morgantown L/D	38	43	54	65	71	75
Point Marion L/D	39	44	56	67	75	81
L/D 7 - Monongahela	39	44	56	67	75	81
Maxwell L/D	39	44	56	67	75	81
L/D 4 - Monongahela	52	59	72	87	104	116
L/D 3 - Monongahela	178	295	394	404	377	311
L/D 2 - Monongahela	283	420	610	649	589	469
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	174	184	304	351	325	276
L/D 3 - Allegheny	421	590	922	1,058	1,075	965
L/D 2 - Allegheny	421	590	922	1,058	1,075	965
Emsworth L/D	1,095	1,543	2,349	2,659	2,636	2,332
Dashields L/D	1,141	1,598	2,452	2,812	2,804	2,499
Montgomery L/D	1,292	1,898	2,883	3,294	3,378	3,118
New Cumberland L/D	1,569	2,216	3,378	3,902	4,146	4,027
Pike Island L/D	1,685	2,396	3,638	4,182	4,417	4,246
Hannibal L/D	1,689	2,400	3,646	4,193	4,427	4,253
Willow Island L/D	1,635	2,361	3,597	4,137	4,361	4,181
Belleville L/D	1,819	2,739	4,197	4,754	5,016	4,771
Racine L/D	1,892	2,823	4,307	4,896	5,284	5,116
London L/D	24	26	29	28	26	24
Marmet L/D	37	71	84	84	72	45
Winfield L/D	232	428	549	563	544	462
Gallipolis L/D	1,918	2,994	4,536	5,086	5,424	5,188
Greenup L/D	1,812	2,790	4,204	4,830	5,307	5,275
Meldahl L/D	1,785	2,732	4,174	4,828	5,205	5,173
Markland L/D	2,442	3,370	4,995	5,935	6,662	6,859
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	2,497	3,253	4,799	5,738	6,774	7,218
Cannelton L/D	2,750	3,435	5,084	6,122	7,170	7,609
Newburgh L/D	3,024	3,711	5,403	6,476	7,667	8,174
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
Uniontown L/D	2,996	3,710	5,411	6,477	7,911	8,606

(continued)

BEST DOCUMENT AVAILABLE

Table G-10. (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 50 - Ohio River	2,996	3,710	5,411	6,477	7,911	8,606
L/D 51 - Ohio River	3,006	3,721	5,425	6,490	7,922	8,614
Smithland L/D	3,176	3,974	5,659	6,746	8,231	8,935
L/D 52 - Ohio River	8,629	10,205	12,877	14,729	17,262	18,536
L/D 53 - Ohio River	8,592	10,163	12,868	14,737	17,259	18,526
Kentucky - Barkley L/D	4,115	4,650	5,614	6,332	7,511	8,256
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	557	620	935	1,187	1,484	1,671
Watts Bar L/D	203	268	404	483	601	669
Chickamauga L/D	361	417	547	617	634	627
Nickajack L/D	839	921	1,257	1,437	1,568	1,580
Guntersville L/D	834	987	1,375	1,618	1,944	2,062
Wheeler L/D	1,173	1,500	2,009	2,373	3,041	3,422
Wilson L/D	1,173	1,500	2,009	2,373	3,041	3,422
Pickwick L/D	1,179	1,506	2,016	2,382	3,053	3,436
Ft. Loudoun L/D	124	185	269	303	290	252
Melton Hill L/D	4	6	9	13	23	31

Note: Tonnages may not sum to totals due to rounding.

a: Group IX: Food and Feed Products, Nec.
Group X: Wood and Paper Products
Group XI: Petroleum Products, Nec.
Group XII: Rubber, Plastic, Nonmetallic Mineral Products, Nec.
Group XIII: Nonferrous Metals and Alloys
Group XIV: Manufactured Products, Nec.
Group XV: Others, Nec.

Source: Robert R. Nathan Associates, Inc.